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CONTENTS

NEW DESCRIPTIONS

REVIEWS

MISCELLANEOUS NOTES

Cover photograph: Wild Tusker

Editorial

The problems facing the Asian elephant in India are a reflection of the state of environmental conservation in India. As a species able to live in a wide spectrum of vegetational types, the elephant acts as an indicator species of the condition of its biotic environment. A sub-optimal habitat is unable to meet the demands made on it by a herd of elephants, whose presence will result in further deterioration. Elephants in such habitats are compelled to seek sustenance elsewhere, and come into conflict with man. At the present rate of habitat loss, and degradation of existing habitats, it is doubtful if present populations can survive. One has to consider seriously the possibility that the Asian elephant will be known mainly as a domesticated animal in the 21st century.

In India, an enormous area of prime elephant habitat has been lost since 1860, to the plantations of coffee, tea, rubber and teak which were carved out of existing forests. After 1950, hydroelectric projects ravaged elephant habitat through the submerging of forests and unscrupulous exploitation of the remnant forests. In central India, the forests holding elephants cover the single largest deposit of iron-ore in Asia, and mining has been a continuing process since 1909. The states of northeast India, which used to be the stronghold of the elephant in India, are the areas where the main human-elephant conflict has developed. Exploding human populations have destroyed crucial elephant habitat for cultivation and plantations, extinguishing traditional migratory routes; and slash-and-burn cultivation has devastated habitats, making unlikely the survival of the elephant in some of the states.

There is also the question of ivory poaching. Though not on as massive a scale as of the African species, the selective removal of tuskers has played havoc in the sex ratio of many populations. The elephant is an apex species, able by its size and its interaction with its habitat, particularly in its quest for food, to influence the direction of development of its biotic environment. It has been one of the causes for the process of change in its ecosystem. Such a function is no longer acceptable in an environment managed by man, where the process of change has been speeded up. The range of the elephant has, through the ages, shrunk considerably. This process was accelerated, however, as the industrial revolution in the latter half of the last century brought a mechanized commercial culture into the countries of its occurrence. The tools used by man in a region decide its future, and the tools of an alien culture, now in use for gathering natural resources for commerce and to meet the needs of an ever-increasing human population, have destroyed a natural slow-moving ecosystem. The elephant has become in the process too large an animal to find sustenance and living room in the shrinking world of nature.

The conservation of the Asian elephant in Asia cannot be the concern of only the forest departments and environmentalists. Conserving the elephant involves the conservation of prime wildlife habitats. This needs a multidisciplinary effort, where the local people, the administrators and land-use planners have to be involved at all levels. Conserving the elephant, therefore, means conserving the human environment, and it has to be a part of the development plans of each state of Asia as a whole. The Asian elephant is a part of the culture of man in tropical Asia. It is an integral part of the religions of the region and one hopes, will not be sacrificed in the search for a better life for the people of the region.

J.C. DANIEL

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POPULATION AND ECOLOGY OF THE INDIAN FOX *VULPES BENGALENSIS* AT ROLLAPADU WILDLIFE SANCTUARY, ANDHRA PRADESH, INDIA[1]

RANJIT MANAKADAN AND ASAD RAFI RAHMANI[2]

(*With six text-figures*)

Key words: Indian fox, *Vulpes bengalensis*, *Ardeotis nigriceps*, population, diet, breeding season, Rollapadu Wildlife Sanctuary, Andhra Pradesh

The population of the Indian fox *Vulpes bengalensis*, its spatial and temporal abundances, den distribution, characteristics and use, predation on eggs and chicks of the great Indian bustard *Ardeotis nigriceps*, and general ecology were studied from February 1993 to April 1995 at the Rollapadu Wildlife Sanctuary (RWS), Andhra Pradesh state, India. The population and spatial abundance of the fox was estimated by enumeration and monitoring of dens, animal sightings at den sites and from censuses.

The population of the fox at RWS was estimated to be around 40-50 adult animals in 1993 and 1994, which declined to about 10 animals in 1995 due to an epidemic. Densities of the fox were significantly higher in the protected grasslands {0.65/40 ha ± 0.99 (S.D)} than unprotected grasslands (0.15/40 ha ± 0.49). A total of 135 dens (active and non-active), comprising of 33 'den groups', were located in the study area. There was a concentration of dens in and around protected grasslands. Den use by the Indian fox at RWS was confined to the pup rearing season (February to June/July). We did not record any evidence of fox predation on bustard eggs and chicks.

INTRODUCTION

The Indian fox *Vulpes bengalensis* is a widespread species in India, ranging from the foothills of the Himalayas to Kanyakumari (Prater 1980). In spite of its wide distribution and proximity to human habitation in many areas, it has not been studied adequately (Johnsingh 1978). The population of the Indian fox in Rollapadu Wildlife Sanctuary (RWS), Andhra Pradesh had undergone a remarkable increase after the establishment of the Sanctuary in the early 1980s to protect the great Indian bustard and its habitat (Manakadan and Rahmani 1989, 1993, 1997). The Indian fox is known to be a predator of eggs and probably chicks of the bustard (Rahmani and Manakadan 1987). This was suspected to be one of the reasons for the decreasing numbers of the great Indian bustard at RWS over the years, in spite of good protection to the bird and its habitat. We undertook this study to estimate the population of the Indian fox at RWS; compare its abundance in protected and unprotected sites in the Sanctuary; assess reasons for the differences in abundance between sites (which could explain the increase in

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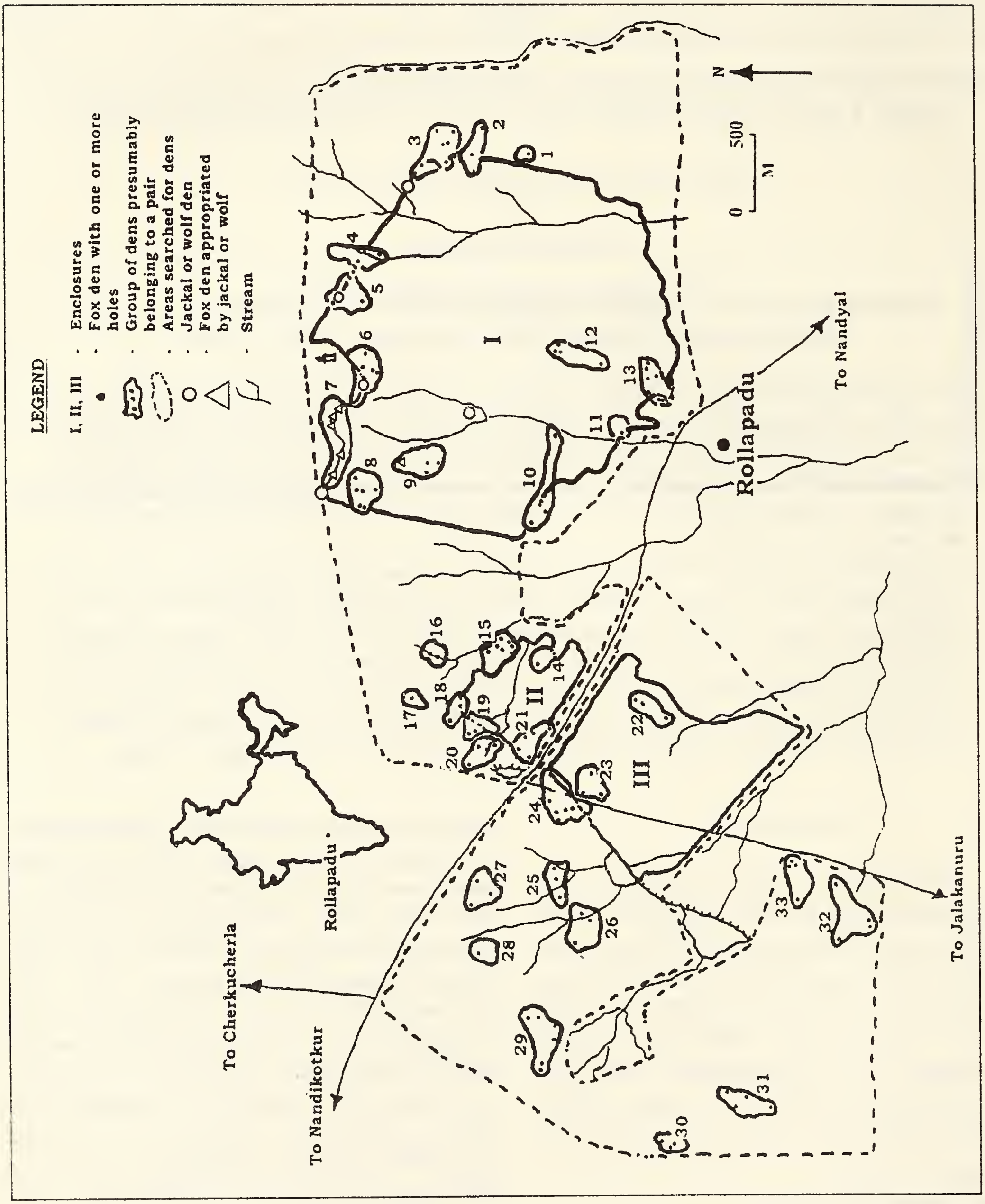

Fig. 1: Location of fox dens in the study area

populations over the years after protection); investigate the role of the fox as a predator of bustard eggs and chicks; and collect other ecological information on the species.

Study Area

Rollapadu is 18 km southeast of Nandikotkur (15°58' N lat. & 78°18' E long.), Kurnool dist., Andhra Pradesh. It lies in the plains between the Nallamalai and Yerramalai hills, at about 200 m above msl. The terrain is gently undulating with predominantly poor red soil. The region is semi-arid with an average annual rainfall of 668 mm, received from both the southwest (June to August) and northeast (September to December) monsoon. Summer (March to May) peaks at 42°C and winter (November to February) is mild at 17° C.

Rollapadu Wildlife Sanctuary (area: 6.14 sq. km) was established in 1982, after the 'rediscovery' of the great Indian bustard *Ardeotis nigriceps*, and was declared a sanctuary in 1988. The sanctuary proper consists primarily of three grassland plots or enclosures: Enclosure-I (320 ha), about 500 m north of Rollapadu, and Enclosure-II (40 ha) and III (120 ha), both about 1.5 km to the northeast of Rollapadu (Fig. 1). These enclosures are demarcated by trench-cum-mound (TCM) walls to exclude livestock and people. However, Enclosure-III was opened to grazing after protests by the locals about the lack of grazing land for their livestock. The extent of protection to Enclosure-II varied from year to year during the study. The three enclosures are separated from each other by grazing lands and crop fields. Both the grazing lands and the enclosures are predominantly grasslands, with scrub dominated areas along streams.

The other major fauna of the Sanctuary include the blackbuck *Antilope cervicapra*, wolf *Canis lupus*, jackal *Canis aureus*, jungle cat *Felis chaus*, common mongoose *Herpestes edwardsi*, blacknaped hare *Lepus nigricollis nigricollis*, common Indian monitor *Varanus bengalensis* and lesser florican *Sypheotides indica*. The grassland is a major roosting ground for harriers (largely *Circus pygargus* and *C. macrourus*) wintering in the Indian subcontinent. For more details, see Rahmani and Manakadan (1986) and Manakadan and Rahmani (1989, 1993 & 1997).

Methodology

Studies were conducted from February 1993 to April 1995, during daylight hours on unmarked animals. Prior to the studies, we had a fairly good idea of the population and distribution of the fox in RWS from July 1992, due to our field visits during other multi-disciplinary studies of the project.

Population: A pilot survey was conducted during the breeding season in 1993 to assess den distribution in the study area. The survey was concentrated in the three enclosures and grazing lands adjoining them, to get an insight into the breeding season, den characteristics and distribution of the fox in the Sanctuary. Den searches were more intensive during the breeding season of 1994 and 1995. Searches in 1994 began in February, when the dens located in 1993 were found to have been dug up afresh, indicating the start of the breeding (pup rearing) season. The area searched (Fig. 1) was divided into smaller blocks and combed intensively for dens by two or three people. The locations of these dens were plotted on a map (Fig. 1) and details, such as active or non-active, number of holes per den, distances between dens, and site characteristics were recorded. After the survey, all the dens were visited once a week to collect data on den use. Sightings of animals (adults and young) at den sites were recorded. We also looked for indirect signs of animal presence, such as freshly unearthed soil, additional holes dug up, pugmarks, presence of scats and food remains at den sites. Visits were made till June (when the animals abandoned the dens with the onset of the monsoons) in 1994, and till May in 1995 (after the breeding season).

Population estimate: Based on the number of dens located, den use data, and number of adult foxes seen at den sites, a rough estimate of the adult population at RWS was determined. Where animals were never seen at active dens throughout the study period, and especially if the den formed part of a complex of dens (termed den group) as in the majority of cases, we presumed that the den / den group belonged to a pair, as two animals for each den group was the norm in most of the den groups.

Densities in grazing land and enclosures: Four sites of 40 ha each were selected in each of the two habitat types. Except for one site in the grazing land, which was predominantly scrub, all the other sites were grasslands. The sites were thoroughly covered on foot fortnightly — on different days — in the evenings from July 1994 to April 1995. Though the sites were searched on different days, repeated flushing of animals from the same areas suggested that the animals were territorial and that there was no significant movement between sites. Each site was searched in an hour's time, by walking at a steady pace, in an irregular and generally zigzag manner. Some light noise (humming, dragging of feet, tapping with a stick) was made to flush the resting, sleeping or hidden foxes inside dens or among vegetation. Loud noise was avoided as it would alert the animal a good distance away, allowing it to slip away without being detected. On flushing a fox, the direction in which it ran and the place it stopped was observed to avoid duplication of counts. The fox sightings were expressed as number of foxes/40 ha.

Food Availability: Data on the abundance of the known food items of the fox, such as fruits (number of fruiting trees) and grasshoppers in the two habitat types was obtained from other studies carried out during the project. Grasshoppers were sampled by the sweep net sampling method (100 sweeps per site), and was done fortnightly at all four sites in both the habitat types. The density of fruiting trees was enumerated by laying 40 quadrats (size 50 x 50 m) each in both the habitat types, and noting the species of trees or shrubs, their numbers and heights. An index of rodent abundance was obtained by enumeration of burrows along one kilometre transects (with a width of two metres), laid at random in both the habitat types. The transects were done during summer (breeding season of the fox). Fifteen transects each were laid in the enclosure and grazing land during 1994 and 1995. For more details, see Manakadan and Rahmani (1997).

Diet: Scats of fox were collected whenever seen, but mostly during the breeding season, when they were available around den sites. The scats were mixed with warm water, strained and dried. After drying, the remains of animal and plant parts were recorded visually. The percentage composition was not estimated systematically, as the main purpose of the exercise was to look for remains of bustard eggs or chicks.

Results

Dens: The breeding (pup rearing) season of the fox in RWS was determined to be between February to May from 3 years observations. The breeding season was heralded by the re-excavation of old dens or digging of new ones in February. Scats of pups were found around den sites during April and May. Pups were seen around the den sites till the onset of the monsoon, after which the dens were abandoned. Thus, den use by the Indian fox at RWS was largely restricted to the pup rearing period.

Fox dens were recorded in grassland or light scrub habitats — none in dense scrub areas. Dens were dug in the flat ground or in trench cum mound walls (TCM) of the enclosures. Two dens were recorded along the slopes of a stream. The number of holes or openings per den varied from one to as high as 43, but two to seven holes were most common (Figs. 2, 3). All the holes of a den were not used, two to seven active holes per den were most frequent. The frequency of

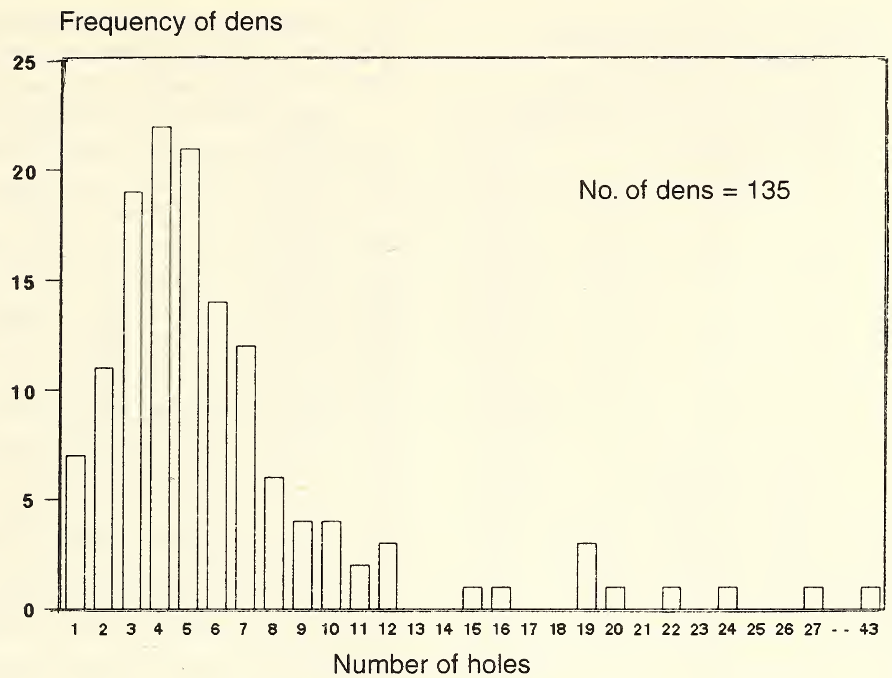

Fig. 2: Number of holes per den

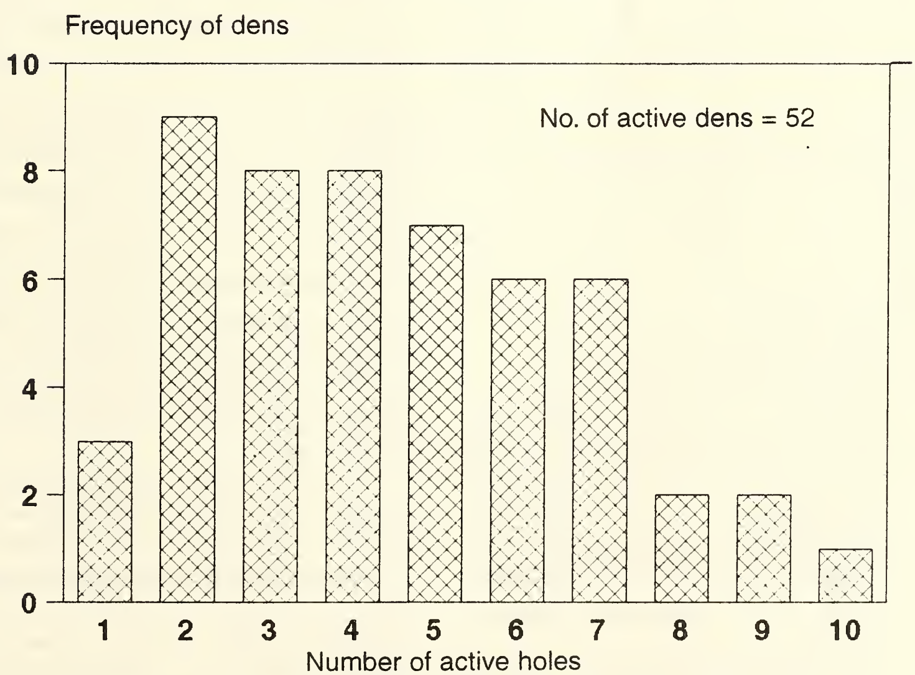

Fig. 3: Number of active holes per den (1994)

TABLE 1
DETAILS AND STATUS OF DEN GROUP
(BASED ON 1994 DATA)

Den Group No.	No. of dens per group	No. of foxes recorded/ estimated	Status in 1994	1993	1995
1	1	0	NA	-	NA
2	4	2*	A	A	A
3	6	2**	LL-A	A	NA
4	5	0	NA	A	NA
5	3	0	O	A	NA
6	5	2*	A	A	NA
7	8	?	NA	A	NA
8	5	2*	A	A	NA
9	5	0	O	NA	NA
10	5	2*	B	A	NA
11	1	0	O	NA	NA
12	4	2**	B	A	NA
13	7	?	A	B	NA
14	2	1*	A	A	NA
15	9	2*	B	B	NA
16	2	0	O	-	NA
17	1	2(?)	LL-A	-	NA
18	2	1*	A	B	NA
19	7	2*	B	A	A
20	4	2**	B	-	NA
21	5	2*	B	A	NA
22	3	0	O	-	NA
23	3	0	O	-	NA
24	8	2**(1*)	A	A	A
25	3	?	LL-NA	-	NA
26	3	2(?)	A	-	NA
27	3	2**	B	-	NA
28	1	1*	A	A	NA
29	5	2**(1*)	A	-	A
30	3	?	A	-	A
31	4	2**(1*)	A	-	B
32	4	2(?)	A	A	NA
33	4	?	LL-NA	B	NA

* - from sightings
** - from signs (scats or intensive burrowing)
2**(1*) - 1 seen, but probably used by a pair.
? - uncertain
A - Active burrows regularly used, dug or redug
NA - Not active, dug early in the season, but later largely or totally unused.
O - Dens of previous years: not dug at all during the year of survey.
B - Breeding (pups or scats of pups seen)
LL-A - Located late (after breeding season); - probably active
LL-NA - Located late (after breeding season); - probably not active
\- - Not located - all or some of the dens of the den group were not located.

active openings in the eight breeding dens of 1994 were six for three dens, five for two dens, three for two dens and nine for one den.

Many of the dens in the grazing land had rodent burrows around them, indicating that these sites had been appropriated from rodents. In some cases, the rodents continued to live in some of the burrows not enlarged by the fox. Re-use of dens by rodents after the fox had abandoned the dens during the monsoon was recorded in some cases. On two occasions, large monitor lizards *Varanus bengalensis* were recorded entering active fox dens. Once, a large monitor lizard, flushed by us near a den site, ran into a fox den, from which a family of gerbils rushed out and ran into their burrows a few metres from the fox den. Seven of the fox dens were appropriated by jackals or wolves (Fig. 1).

During the preliminary non-intensive searches for dens in 1993, a total of 52 dens were located (33 active and 19 non-active). Breeding activity was detected in 4 dens: 1 in Enclosure-I, 2 in Enclosure-II and 1 in the grazing land. During intensive searches in 1994, a total of 135 dens were located, of which 52 were active. Of the 135 dens, 51 were in Enclosure-I, 15 in Enclosure-II, 9 in Enclosure-III and 60 in the grazing land. As much as 31% of the dens in the grazing land were close to Enclosure-I and II. Breeding activity was recorded in eight dens: three dens each in Enclosure-I and Enclosure-II; one each in Enclosure-III and grazing land. During the breeding season in 1995, no additional dens were located. Of the dens located in 1994, only eight dens were reused (active). Breeding was confirmed at only one den in the grazing land.

From the data on sightings of animals and den use, it was evident that many of the foxes used more than one den. From this data, the 135 dens located during the intensive survey in 1994 were grouped into 33 den groups, of which 22 were active (Table 1 & Fig. 1). Dens of a group generally tended to be clumped in an area, the distances between dens varying from as close as

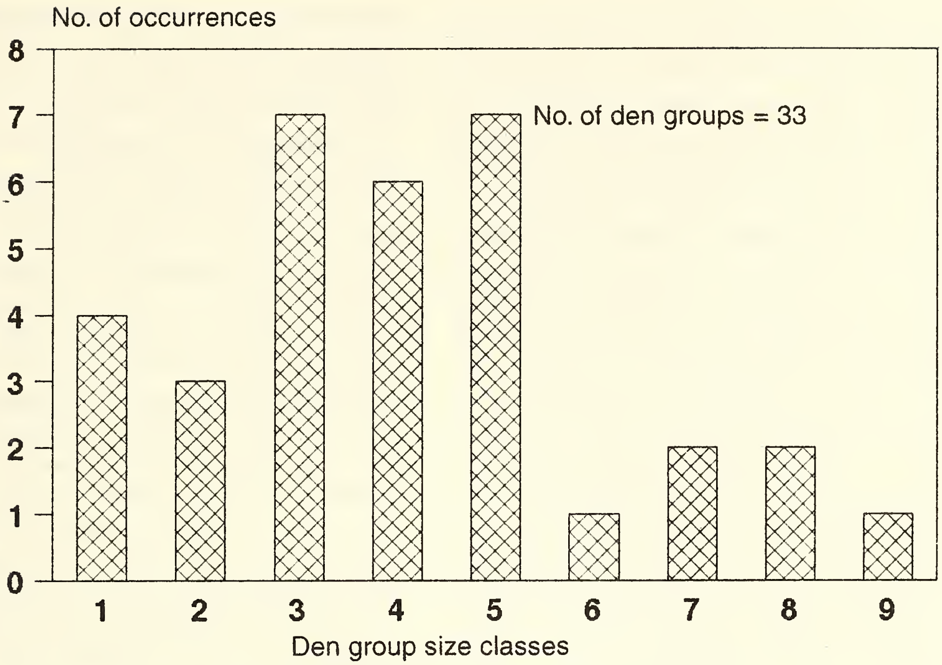

Fig. 4: Number of dens per den group (1994)

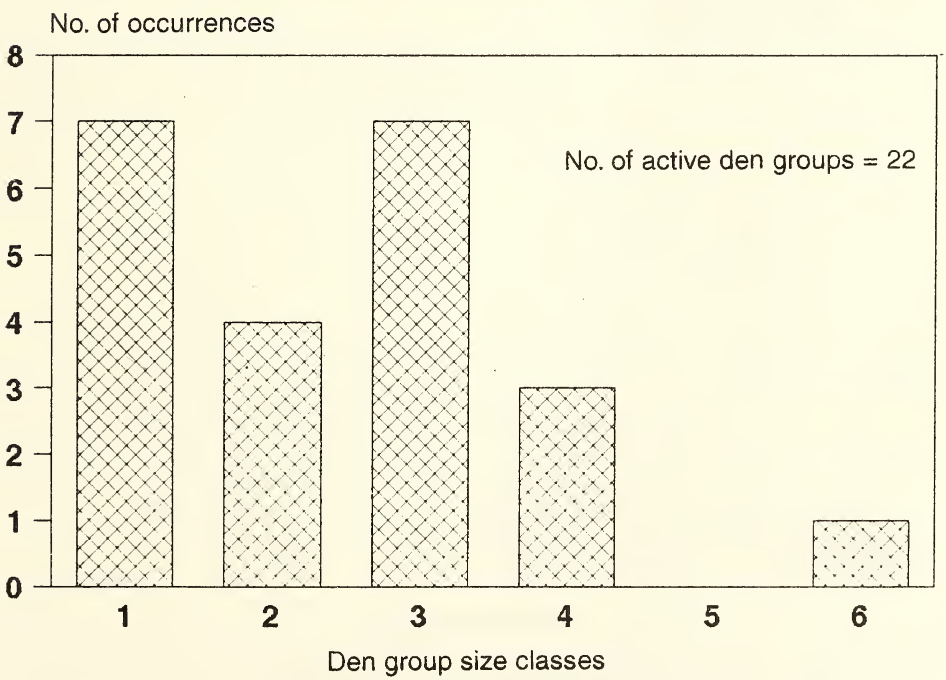

Fig. 5: Number of active dens per den group (1994)

12 m to 100 m. In some cases, the distance of a den from the main cluster was more than 200 m (e.g., den group no. 10 - Fig. 1), but these were clumped to the group, based on sightings and movements of adult and young foxes between dens. In some cases, we grouped two clusters of adjoining dens into one (e.g., den group no. 7), as one of these clusters was hardly used and was probably the denning site of the pair in the area during a previous year. The distances between den groups varied, and were less in the enclosures {Enclosure-I: 463.6 m ±283.8 (S.D.), Enclosure-II: 275.0 m ±302.9, Enclosure-III: (400.0 ±424.3) than the grazing land (633.3 m ±314.3)}. The number of dens per den group varied from one to nine dens, with three to five dens being most frequent (Fig. 4). However, not all dens in a den group were active during a year, one to three active dens was most common (Fig. 5). We presume that each (active) den group belonged to either a pair of foxes or rarely individuals, but cannot be certain as the animals were not collared, the nocturnal movements were not monitored, and a few dens showed all signs of regular use (especially those in the grazing lands), but no animals were sighted in them.

Population: We regularly saw five pairs of foxes around Enclosure-I (den group 3, 6, 8, 10 & 13), four pairs around Enclosure-II (den group 14, 15, 19, 21), three pairs in the grazing lands east of Enclosure-III (den group 25, 31 and 33), and a single individual at den group 28 during our field trips in 1993 and 1994 — a total of 25 foxes. Judging from the number of dens and groups, den use data, and sightings of the animal around dens during the census, it is estimated that about 40-50 foxes were present in the study area during the 1994 breeding season. About the same numbers should have been present during 1993. In 1995, the population dropped to about 10 animals due to an epidemic.

The foxes were usually seen in pairs around the den-groups. Two instances of four adult animals frequenting a common area was

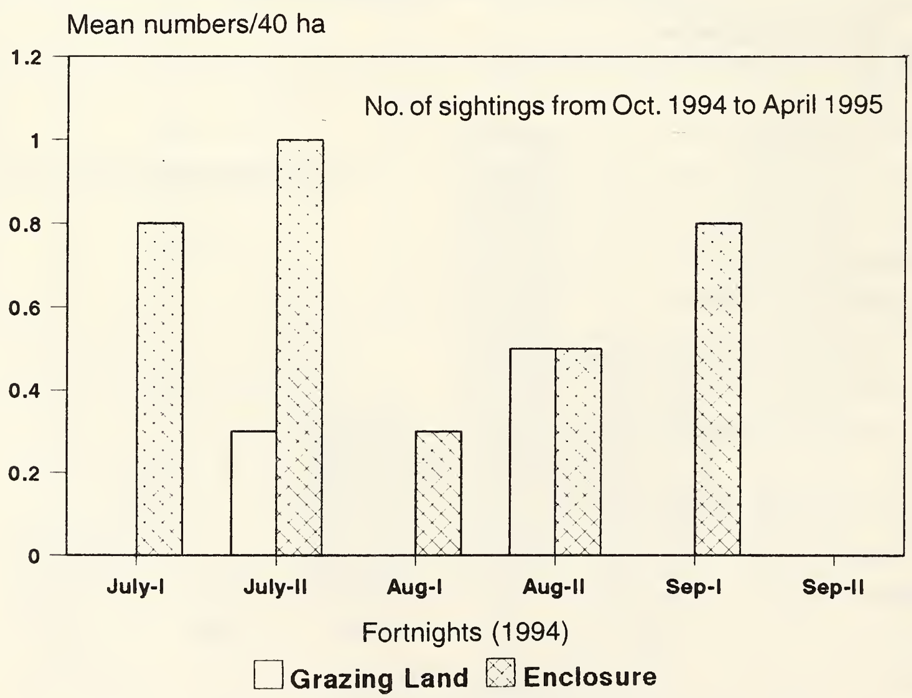

Fig. 6: Abundance (sighting / 40 ha) of the Indian fox in the two habitats

observed. In the first instance, it was during the early monsoon period, when four animals (probably pairs from nearby waterlogged dens) regularly sheltered under a fallen tree as the grass cover was burnt off in a summer fire. In the other instance four adult animals were flushed from a non-breeding den in summer. Otherwise, pairs were the norm and even in clumped den areas, the pairs kept to themselves. Solitary animals were flushed from dens on a few occasions, but the possibility of the mate sleeping elsewhere unnoticed cannot be ruled out. The only den where solitary animals were repeatedly flushed, was at den group 28, which comprised of only one den with a single entrance. Additionally, this was the only single-hole den from which we had actual sightings of the animal.

Abundance of the fox was significantly higher ($U=140$, $P<0.05$) in the enclosure (mean 0.65/40 ha, S.D. $\pm$ 0.99) than in the grazing land (mean 0.15/40 ha S.D. $\pm$0.49). The fox was recorded during all the fortnights in the enclosures from the first week of July 1994, till the first week of September 1994 (Fig. 6). In the grazing land, the fox was recorded only during two fortnights between July to August 1994. In both cases, the foxes were close to Enclosure-II, and ran into it on being approached. All the sightings in the grazing land and enclosures were in 'grassland habitats', none in scrubland. After the second week of September 1994, there were only rare sightings of the fox in the Sanctuary. The remains of five foxes and two wolves were found at different places between July to September. The locals too reported seeing dead foxes. After the epidemic, the only sightings were of single animals, one each in Enclosure-II and the grazing land (den group No. 31) during March and April 1995.

Food Availability

Fruits: Of the two species of fruits recorded to be eaten by the fox, the density of *Cassia fistula* was higher in the enclosure (1.8 trees/ha) than in the grazing land (0.2 trees/ha). Though the density of *Zizyphus mauritiana* was about the same in the enclosure and the grazing land, the trees were relatively taller in the enclosure (mean = 1.5 m) than in the grazing land (mean = 0.65 m), and yielded more fruit. Other fruits that could probably be part of the diet of the fox are *Morinda tinctoria* and *Phoenix sylvestris*. Trees of these two species were more abundant in the enclosure (0.6 and 5.2 trees/ha respectively) than in the grazing land (1 tree/ha for *P. sylvestris*; *M. tinctoria* not recorded). The higher densities of fruiting trees and fruit yield, and restrictions on harvesting of fruits in the enclosures, make the availability of fruits greater in the enclosure than grazing land.

Grasshoppers: Insect sampling showed that there was a slightly higher abundance of grasshoppers in the enclosure than in the grazing land. Besides numerical abundance, there was greater insect biomass availability in the enclosure due to the predominance of a larger species of grasshopper (*Acorypha*), compared to a smaller species (*Chrotogonus*) in grazing land. Studies on the great Indian bustard have shown that *Acorypha* is preferred to *Chrotogonus*, especially by adult birds (Manakadan and Rahmani 1990). The fox would also find feeding on the larger species more profitable.

Rodents: Rodent burrows were recorded only in the grazing land in 1994 and 1995. Of the 15 transects each laid in the grazing land for both the years, a total of seventeen burrows (2 active and 15 non active) were recorded in five transects during 1994, and nine burrows (6 active and 3 non-active) were located in 5 transects during 1995.

Diet: Analysis of 58 scats showed the presence of rodents, hare, monitor lizard and grasshoppers (predominantly *Acorypha* sp.) among the animal matter. Among vegetable matter, seeds of groundnut *Arachis hypogea*, *Zizyphus mauritiana* and *Cassia fistula* were recorded. Remains of eggs or chicks of the great Indian bustard were not recorded. Scats of pups were almost solely made up of rodent fur.

Threats: The potential predators of the fox at RWS are the wolf, jackal, jungle cat, monitor lizard (on young), and large raptors. Wolves and jackals were seen digging (to eat cubs?) or appropriating fox dens during the breeding season. Large monitor lizards were also seen entering dens on a few occasions. The remains of two foxes, with the flesh stripped off neatly from the bones, were found, indicating that the kills were made by birds of prey. A local reported seeing a dog killing a fox (during the epidemic), but we observed play between a fox and a half grown dog (at a good distance away from each other). The local people do not eat the fox, but two communities, the *Pardhis* based at Nandikotkur and a nomadic beggar community, hunt and eat them. We recorded three dens that were smoked and dug out in the grazing land. Poachers do not hunt in or near the enclosures, for fear of being caught by the Forest Department.

Discussion

Fox populations often increase steadily with the years, reach levels of overpopulation or saturation, and then decline rapidly due to epidemics (Rausch 1958, Prater 1980, Wandeler *et al.* 1974, Malcolm 1986, and Ginsberg and Macdonald 1990). In RWS, the population of the fox had increased from half a dozen animals during 1985-87 (Manakadan and Rahmani 1987) to about 40-50 animals during 1992-94. It then dropped down to about 10 animals in 1995 due to an epidemic. Canine distemper and rabies are common among canids and could be an important factor in controlling populations, especially of the fox, due to their greater numbers and density (Mech 1970, Wandeler *et al.* 1974 and Malcolm 1986). The increase in population of the fox in the Sanctuary could have been a natural occurrence, or brought about by the protection of the species and its habitat after the establishment of the Sanctuary.

Scrub control is suggested as a management tool to aid detection and avoidance of terrestrial predators of the San Joaquin kit fox *Vulpes macrotis mutica* (Warrick and Cypher 1998) and the desert kit fox *Vulpes macrotis arsipus* (Zoellick *et al.* 1998). Tree and shrub growth at RWS has increased significantly, especially bordering streams (Manakadan and Rahmani 1997), and the fox or its dens were not recorded in such habitats. Scrub control appears necessary in such areas, as it gives cover to potential predators of the fox, such as wolf, jackal and jungle cat, to stalk the species. The fox was recorded in light scrub areas, which appear important for resting and shelter during the day (especially during the non-denning period), and may be vital to the species to escape aerial predators (such as eagles), especially in overgrazed or burnt areas.

Digging of dens in trench cum mound (TCM) walls is easier due to the loose soil and rubble on the trenches, and this may explain the concentration of dens in the enclosures and TCM walls. Most areas of grazing land had shallow soil, exposed rock beds and a calcareous layer, which made digging of dens difficult. In the case of the Arctic fox *Alopex lagopus*, Eberhardt *et al.* (1982) mentioned that den sites were restricted to areas where the permafrost was sufficiently deep and soil characteristics allowed burrowing. It is also likely that absence of poaching results in the concentration of dens in an area. This is because the young have greater chances of survival, and on maturity, some of them dig dens in the vicinity of their parents' dens, especially since foxes are social canids. This may explain the clumped distribution of dens and den groups in the protected enclosures, in contrast to relatively dispersed distribution in the grazing land.

Although TCM walls may attract the fox for denning, it is primarily protection, habitat improvement and lack of disturbance that have attracted them to the enclosures. This explains why dens were concentrated in Enclosure-I and II (protected plots), but not in Enclosure-III (unprotected). Malcolm (1986). and Ginsberg

and Macdonald (1990 - quoting various sources) reason that clumping of fox dens is an indication of good habitat. Trottier (1992) mentioned that the swift fox *Vulpes velox* prefers grass of moderate height. This may also be true for the Indian fox, for respite from the heat and protection from aerial predators, especially eagles. The protected enclosures were relatively free of human disturbance. Foxes in the grazing land were frequently disturbed by the movements of people, graziers and dogs. During our visits to the dens, sightings of animals were common around den sites in the enclosures, but were rare in the grazing land. It was not clear whether the foxes in the grazing land come out of their dens only at dusk to avoid frequent disturbance (and were hence missed during our visits), or they took refuge elsewhere during the day.

Multiple den use is likely to be both, a strategy to confuse predators (jackal and wolf) and for sanitation. In the desert kit fox *Vulpes macrotis arsipus*, individuals were reported to use 3-16 dens, while pairs use 9-16 dens (Zoellick *et al.* 1998). Canids are known to move their pups regularly to different dens (Sargeant *et al.* 1975), and this has also been reported in the Indian fox (Johnsingh 1978). Sargeant *et al.* (1975) recorded splitting of litters among two or more dens in the red fox *Vulpes vulpes*. In this study, it was observed that usually after breeding and occupancy of a den for about two months, the pair shifted to another den nearby and even to a third den later on. Half grown pups then frequent all such dens of the den group.

Johnsingh (1978), from his studies in Madurai dist., Tamil Nadu, recorded dens with either two holes or the more common multiple opening dens (maximum of 23 holes). In this study, except for a few single hole dens, the rest were multiple hole dens (up to 43 openings). A greater number of holes per den probably indicates the use of the dens by the same pair for many years, as stated by Johnsingh (1978). However, unlike Johnsingh's findings, areas around dens in RWS had less vegetation compared to the surrounding areas. This is because the soil at RWS has a calcareous layer. This layer when brought to the surface by the foxes digging, hinders plant growth.

The extent of predation on bustard eggs and chicks by the fox was not established. Remains of eggs or chicks were not recorded in the scats analysed, probably because most scats were not collected in the major breeding season of the bustard. It is also unlikely for egg shell pieces to appear in the scats, as the fox might lick the egg contents and leave the shell. In some cases of nest predation recorded during this and the earlier study [predator not known] shell pieces were found strewn around the nest sites. As for chicks, not much identifiable matter could be expected in the scats, except for the bill or claws.

A major drawback of our studies on the Indian fox was that we could not investigate the nocturnal activities of this largely nocturnal species. Also, it was not possible to identify individuals from body characteristics since the animals were not marked. A study of radio-collared animals with the help of night vision equipment is essential to get precise information on the species.

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BREEDING BIOLOGY OF THE MALABAR GREY HORNBILL (*OCYCEROS GRISEUS*) IN SOUTHERN WESTERN GHATS, INDIA.[1]

DIVYA MUDAPPA[2]

(*With one text-figure*)

Key words: hornbill, tropical rainforest, frugivory, seed dispersal, cavity-nesting, breeding biology

The Malabar grey hornbill (*Ocyceros griseus*) is a frugivore, endemic to the tropical rainforests and moist deciduous forests of the Western Ghats hill ranges, India. I studied its breeding biology in the Anamalai hills (Indira Gandhi Wildlife Sanctuary), Tamil Nadu state, by monitoring 10 nests and their middens, and conducting intensive observations at a focal nest. The nesting period lasted an average of 86 days (N=4), and observations at the focal nest revealed the pre- and post-hatching phases to be 40 and 46 days, respectively. At the end of the nesting period, the females and the young simultaneously broke out of the nests. A total of 2397 items of food were delivered by the male hornbill to the inmates of the focal nest. They included 6 species of lipid-rich and 8 species of sugar-rich fruits, and at least 14 kinds of animal matter. Lipid-rich fruits formed a major component (*c.* 37%) of the diet during nesting. *Ficus* fruits formed 26%, and animal matter 13.8% of the diet of the incarcerated hornbills. The frequency of sugar- and lipid-rich fruits delivered per hour of observation was significantly greater in the pre-hatching phase. While the frequency of animal food delivered was higher in the post-hatching phase. Although the Malabar grey hornbill used a wide range of food resources, it was observed that a few species of rare, tropical trees producing lipid-rich fruits during the nesting period, play an important role in the maintenance of the species.

INTRODUCTION

Hornbills (Aves : Bucerotidae and Bucorvidae) are a group of large, forest and savanna birds restricted to the Old World tropics. There are 54 species of hornbills in the world (Kemp 1988, 1995), nine of which occur in India (Ali and Ripley 1987). Only in the last two decades, a few studies have provided valuable insights into the ecology of these unique cavity-nesting birds (Hussain 1984, Kannan 1994, Kemp 1976, 1978, 1988, Kinnaird 1993, Leighton 1982, Poonswad 1995, Poonswad and Tsuji 1989, 1994, Reddy *et al.* 1990, Reddy and Basalingappa 1995). Hornbills are secondary cavity-nesters, and the forest-dwelling species are predominantly frugivorous. Their breeding cycles are synchronous with food productivity of the forest (i.e., fruiting phenology; Kannan 1994), but they are also dependent on keystone resources like *Ficus* for their survival in times of low food availability. They exhibit wide-ranging movements to meet their specialized food requirements (Poonswad 1994). Functionally, they have been described as keystone mutualists (Gilbert 1980) as they play an important role in the dispersal of many rare rainforest tree species (Kinnaird 1998, Whitney *et al.* 1998).

The present study aimed to determine the nesting habitat requirements and breeding biology of the Malabar grey hornbill, endemic to the Western Ghats. The former aspect is dealt

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with elsewhere (Mudappa and Kannan 1997). This paper describes in detail: 1) nesting activities and behaviour of the male and female hornbill, 2) duration of nesting period and distinct phases of the nesting cycle, and 3) qualitative and quantitative data on the food delivered by the male to the incarcerated female and young, in relation to the phases of the nesting period. The results are compared with other hornbill species, their reproduction and survival strategies, and the implications for the conservation of this rainforest endemic are discussed.

Study Area

The study was undertaken between December 1993 and May 1994 at the Indira Gandhi Wildlife Sanctuary (10°13' - 10°33' N and 76°49' - 77°21' E, an area of 968 km^2) in the Anamalai Hills of the southern Western Ghats, in Tamil Nadu state, India. A one-month long preliminary study was carried out in the area in May-June 1993, when 15 nests were discovered and seeds from the middens were collected and identified for future reference. The nests selected for intensive observation and monitoring were in the 5.1 km^2 wet evergreen forest patch of Karian Shola National Park. This forest, classified as a Southern Tropical Wet Evergreen Forest (Champion and Seth 1968), receives an annual rainfall of about 1500 mm. The terrain is hilly, and the altitude ranges from 350 m to 2400 m above msl in the Sanctuary, which extends into Parambikulam Wildlife Sanctuary and Eravikulam National Park in the adjacent Kerala state. The forest is contiguous with moist deciduous, teak (*Tectona grandis*) and bamboo forests in the surrounding areas.

Study Species

Of the 9 species of hornbills in India, the Malabar grey hornbill (*Ocyceros griseus*), is the smallest. It is endemic to the Indian subcontinent, occuring only in the heavy rainfall tracts of the Western Ghats hill ranges. Most of the information on the Malabar grey hornbill and other Indian hornbills is anecdotal with notes on natural history. Early papers dealing with nidification of the Malabar and the common grey hornbills (*Ocyceros birostris*) are those of Bingham (1879), Hall (1918), Lowther (1942), and Abdulali (1942). More comprehensive information on their ecology and behaviour was provided by Ali and Ripley (1970, 1987) and Kemp (1978).

The Malabar grey hornbill is sexually dimorphic: the male has a large, bright orange bill and golden brown iris, while the female has a relatively small and pale-coloured bill and dark brown iris. The species is monogamous, the nesting pair usually exhibiting high nest-site fidelity, occupying the same nest-cavities every year (Kemp 1978, Ali and Ripley 1987, Mudappa and Kannan 1997). The Malabar grey hornbill exhibits biparental care like most other monogamous birds with altricial young (Clutton-Brock 1991). While the incubating female is incarcerated, the male provisions her and the other inmates of the nest.

Methods

Active nests of the Malabar grey hornbill were located with the help of a local field assistant, by following the parent birds, and by checking for signs of previous nesting, such as seeds and faecal remains (midden) at the base of the nest trees. Fifteen nests were located during the preliminary study in May 1993. Seeds collected from the midden were catalogued and used for reference during the study. Twelve additional nests were discovered during the initial half of the study (December 1993 to March 1994). Ten nests were chosen for monitoring during the nesting period (the period of incarceration of the female and the young) in Karian Shola National Park. Of these, one was

selected on the basis of logistics for intensive observation.

Intensive observation of a focal nest: The focal nest was observed from the last week of January 1994 to May 1994, for approximately six-hour intervals on every alternate day (more or less uniformly) throughout the three-month nesting period. Observations were made between 0700 h and 1300 h. The forenoon was chosen for nest observation, while the rest of the day was used to visit the other nine nests.

I observed the nest to gather information on the quantity and quality of food delivered by the male to the incarcerated inmates. The food was broadly classified as plant and animal food. The plant food was further categorised as: a) figs, b) sugar-rich non-fig, and c) lipid-rich fruits, based on McKey (1975) and Snow (1981). Observations were made from a ground hide about 18 m from the base of the focal nest through a 7x50 binoculars or a 20x50 spotting scope. For each visit by the male hornbill to the nest, I recorded the number and type of food items delivered, the duration of the visit (to the nearest 5 seconds), and the total number of visits during each sampling/observation session. *Ad libitum* observations on other activities like nest-cavity sealing, cleaning, excretion, begging by the inmates, and the behaviour of the male during the time of food delivery were recorded. At the end of each session, the seeds and other faecal remains in the midden were examined, identified, classified, and counted.

Nest midden monitoring: Ten nests (including the focal nest) were visited regularly to note the status of nesting, quantify the regurgitated or excreted seeds of the fruits eaten by the inmates, and to identify the other debris in the midden. Of the food items consumed by the nest-cavity inmates, only non-digestible parts such as seeds of fruits, elytra of insects, and reptile scales occur in the midden. All distinguishable midden remains were collected, identified, counted, and recorded. The midden below the nest-tree was cleared of all debris after each visit. Small seeds and animal matter in the faecal remains could not be quantified. The presence of Malabar grey hornbill feathers in the midden was taken to indicate moulting. Similarly, the presence of egg-shell in the midden, or the characteristic begging calls of the young, were evidence of hatching or the presence of chick(s) in the nest.

Statistical analyses: The frequency of food items delivered during the nesting period was calculated. Differences between the food (type and quantity) consumed between the two distinct phases (pre- and post-hatching) of the nesting period were tested for statistical significance using Mann-Whitney U test (Seigel and Castellan 1988), using SPSS/PC+ computer software (Norušis 1990). The difference in the occurrence of seeds (frequency) in the midden was tested for significance, using the non-parametric Mann-Whitney U Test similar to the analysis of direct feeding observation.

Results

Characteristics and occupation of focal nest: The focal nest cavity was located at about 14 m on an *Artocarpus lakoocha* (Moraceae) tree. The diameter at breast height (1.2 m) of the focal nest tree was 56 cm, the height 25 m, and the estimated diameter at nest height was 50 cm. The cavity entrance was circular in shape, and oriented towards northwest. My field assistant observed a bird entering the nest cavity in the first week of February. This was probably an instance of nest preparation, cleaning, and widening of the nest entrance.

After this, there was regular movement of the breeding pair in the vicinity of the nest-tree. On February 17, the female hornbill was seen entering the nest-cavity. The cavity entrance was then half-sealed. The male and the female visited the nest (8 times in 6 hrs). During these visits, they appeared to be enlarging the cavity entrance.

The female was in the nest on February 18, and was seen sealing the cavity entrance, leaving only a slit, through which the male fed the inmates during the nesting period.

The male was never observed to be involved in nest sealing, repair, or delivering any kind of sealing material, unlike the female which often repaired the seal with its bill. The female was seen cleaning the nest-cavity by throwing out a lot of seeds and woody debris. The female hornbill used her own excreta, rich in *Ficus* seeds, as material for sealing the cavity entrance. The inmates effected nest sanitation by squirting their excreta out through the slit-like opening of the cavity entrance.

Nesting period: The nesting season lasted for about three months, between February and May in the study population of the Malabar grey hornbills. The nesting period could be distinguished into two main phases: the pre-hatching and the post-hatching phase. However, each phase in turn has been further divided into 3 sub-phases (fortnightly) for analysis. The nesting period in the focal nest was 86 days, commencing from February 18 (incarceration of the female) to May 15 (emergence of chick and female from the nest). The mean duration of the nesting period was 86 days ($\pm$ 2.7 S.D.; N=4).

In the focal nest, the young hatched 40 days after the incarceration of the female. The post-hatching phase was 46 days. Only one chick appeared to have fledged. The female and young broke out of the nest together. Details of the nesting period in the ten nests are given in Table 1.

Clutch size and moulting: The clutch size in the breeding population could not be determined. In the focal nest, only one young was seen. One nest when examined on March 1, 1994, had only one egg. A week later, there were two eggs in this nest. The female resealed the cavity entrance and bred successfully.

Flight feathers were collected from the midden occasionally, particularly in the month of April. The rectrices were never found and the female of the focal nest had tail feathers throughout the nesting period. These could be seen while the bird was ejecting the faecal matter through the slit. However, rectrices had been collected from the midden of six nests during the preliminary study in 1993. Thus, it is likely that the moult in this species is partial.

Table 1

DATES OF INCARCERATION AND FLEDGING IN THE STUDY NESTS

Nest number	Date of incarceration	Fledging date
1.	17 February	16 May
2.	15 February	3 May
3.	18 February	13 May*
4.	18 February	15 May*
5.	21 February	16 May
6.	18 February	18 April**
7.	4 March#	11 May*
8.	17 March#	13 May
9.	3 March#	16 May
10.	18 February	15 May

* — The chick fledged between this day and 20 May

** — Abandoned

\# — Nests discovered after the nesting had commenced

Food delivery by the male hornbill: The focal nest was observed for a total of 161 hours and 45 minutes. All through the nesting period, the male provisioned the incarcerated female and later, the young also. A total of 2,397 food items, which included 11 kinds of fruit, 5 species of vertebrates, and at least 8 types of invertebrates, including 6 types of insects, were delivered by the male (Appendix). Lipid-rich fruits predominated in the diet of the incarcerated hornbills, constituting 36.9% of the food delivered. Other food categories were *Ficus* 26%, sugar-rich fruits 22.6%, and animal matter 13.8%. If there were several items, these were regurgitated one by one. Large fruits and vertebrate prey were usually brought as single items.

The number of food items delivered peaked during the pre-hatching phase, and declined thereafter, being minimum before the fledging of the young. The frequency of lipid-rich and

APPENDIX

PLANT AND ANIMAL FOOD DELIVERED AT THE NEST BY THE MALE MALABAR GREY HORNBILL

A: Plant food (fruit)

S.No.	Species (Family)	Habit	Number in pre-hatching phase	Number in post-hatching phase
Sugar-rich Fruit				
1.	*Ficus* spp. (Moraceae)	Tree/ Strangler	443	123
2.	*Mimusops elengi* (Sapotaceae)	Tree	17	–
3.	*Bridelia* sp. (Euphorbiaceae)	Climber	417	13
4.	*Elaegnus conferta* (Elaegnaceae)	Climber	4	–
5.	*Linocera intermedia* (Sapindaceae)+	Tree	–	–
6.	*Syzygium* spp. (Myrtaceae)+	Tree	–	–
7.	*Filicium decipiens* (Oleaceae)*	Tree	–	–
8.	*Zizyphus nummularia* (Rhamnaceae)	Shrub	61	–
9.	*Glycosmis pentaphylla* (Rutaceae)	Shrub	11	–
	Lipid-rich Fruit			
10.	*Uvaria* sp. (Annonaceae)	Climber	510	63
11.	*Neolitsea* sp. (Lauraceae)	Tree	173	52
12.	*Cinnamomum* sp. (Lauraceae)	Tree		
13.	*Persea macarantha* (Lauraceae)*	Tree	–	–
14.	*Litsea* sp. (Lauraceae)+	Tree	–	–
15.	*Beilschmedia* sp. (Lauraceae)	Tree	–	19
16.	*Myristica dactyloides* (Myristicaceae)*	Tree	–	–
17.	*Knema attenuata* (Myristicaceae)*	Tree	–	–
18.	*Polyalthia* sp. (Annonaceae)+	Tree	–	–
	Other Fruits			
19.	*Strychnos nux-vomica* (Loganiaceae)*	Tree	–	–
20.	Unidentified**			

\+ — Found in the midden of the focal nest

* — Found in the middens of other (non-focal) nests

** — Ten species whose seeds were found in small numbers in the middens (three were found in the midden of the focal nest)

B: Animal Food

Vertebrates

1. Young bird
2. Snake
3. Lizard (*Calotes* sp.)
4. Gecko
5. Frog

Invertebrates

1. Beetle
2. Cricket/Grasshopper
3. Cicada
4. Stick Insect
5. Caterpillars
6. Winged insect (wasp, termite, etc.)
7. Millipede/Centipede
8. Scorpions

Total number of animal food items delivered during the nesting period = 491.

non-fig sugar-rich fruits was significantly higher in the pre-hatching phases (Mann-Whitney U test, $N=16$, $U=24$, $p<0.001$ and $U=36$, $p<0.001$, respectively). Figs were eaten consistently throughout the nesting period. The frequency (number per hour of observation) of animal matter delivered was greater in the post-hatching phase (Mann-Whitney U test, $U=41$, $p=0.047$ for invertebrates and $U=64$, $p=0.014$ for vertebrates; Fig. 1). Within the pre-hatching phase, the frequency of lipid-rich fruits was significantly higher than the other types (Kruskal-Wallis

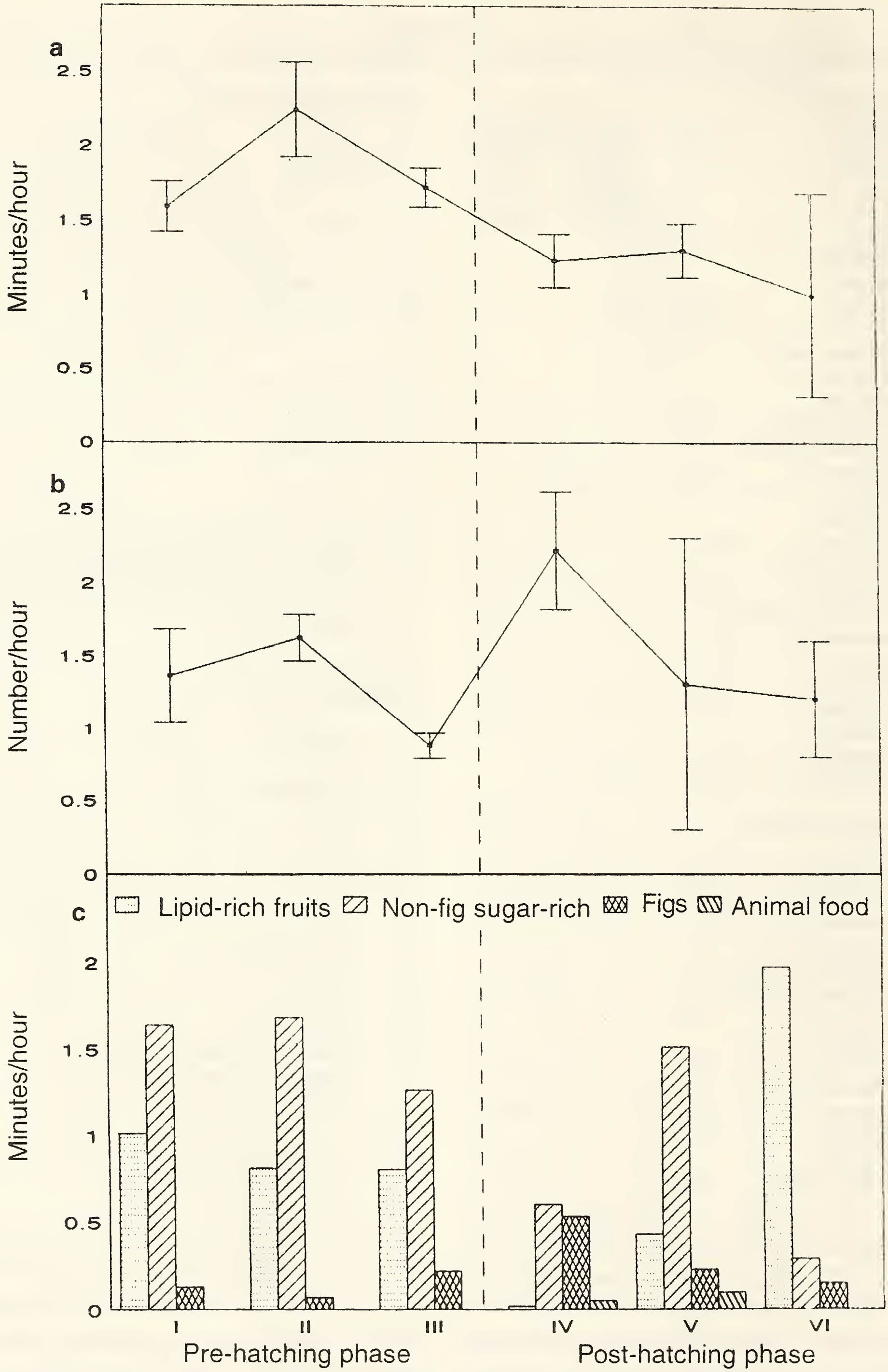

Fig. 1: a. Time spent at nest by the male, b. Visiting rate of the male, and c. Frequency of different food items delivered to the inmates by the male during the nesting period.

χ^2=13.48, df=3, p<0.001), while in the post-hatching phase, animal food was significantly greater (χ^2=23.26, df=3, p<0.001).

Time spent at nest and visitation rate of the male: The time spent and the visitation rate of the male hornbill was influenced by the number and type of items delivered. Time spent (minutes per hour of observation) was significantly higher (Mann-Whitney U test, U=38, p<0.01) in the pre-hatching than in the post-hatching phase, as a greater number (69.5%) of small fruits ($\leq$ 1.5 cm) was delivered (each had to be regurgitated individually). The visitation rate did not differ between the phases (Fig. 1).

Feeding habits — evidence from middens: Supplementary data from the middens of the ten nests showed that nine additional species of fruits were consumed by the incarcerated hornbills (e.g. *Strychnos nux-vomica, Litsea* sp., *Persea macarantha*, see Appendix). A few seeds of ten unidentified plant species were collected from some middens. There was no significant difference between the pre- and post-hatching phases in the frequency of the lipid-rich fruit seeds collected in the midden. The frequency of non-fig sugar-rich fruit seeds in the midden was found to be significantly greater in the pre-hatching phase (Mann-Whitney U test, N=21, U=116, p=0.007).

Predation on Malabar grey hornbill and nest intrusion: Two cases of mortality of Malabar grey hornbills were recorded. The first was of a young bird found towards the end of the nesting period during the preliminary study in 1993. The second was presumably an adult, whose remains were found in the middle of the nesting period in 1994, close to a regularly monitored nest which had been abandoned five days earlier.

The focal nest was once visited by three hill mynas (*Gracula religiosa*) that flew away at the approach of the male hornbill. A Malabar giant squirrel (*Ratufa indica*) and the dusky-striped palm squirrel (*Funambulus sublineatus*) were other inquisitive visitors to the nest, but were apparently disregarded by the incarcerated female.

Discussion

The 32 species of Oriental hornbills are essentially forest-dwelling, arboreal birds (Kemp 1988, 1995). These species, including the Malabar grey hornbill, are long-lived, and have a distinct and relatively long nesting period. The nesting period of the Malabar grey hornbill lasted an average of 86 ($\pm$ 2.7 days) during this study. The success of this bird as a rainforest specialist can be attributed to its life-history strategies (the long and peculiar nesting behaviour), and the adaptation in food habits.

Predation of adult Malabar grey hornbills by animals other than man is rare. Even during the vulnerable period of incarceration, the chances of predation are low, because the nest-cavity entrance is sealed, and the female with her large, armoured bill can protect the nest from intruders. This protection, along with the cavity nesting habit, can be the reason for the long incubation period of these birds.

Overall, the nesting period and food delivery by the Malabar grey hornbill in the area, as in the case of great pied hornbill (*Buceros bicornis*), seems to be associated with fruiting phenology, and the onset of the southwest monsoon (Kannan 1994). Studies in Thailand (Poonswad *et al.* 1988) have found the nesting of hornbills to commence and terminate later than in this region, probably because of the later monsoon. Hornbills subsist on an array of diverse, locally rare, tree species (e.g. members of the Lauraceae; Kannan and James 1999). The nesting period coincides with the peak in fruit availability, as shown by the fruiting phenology study of Kannan and James (1999). Large numbers of rainforest trees of the families Lauraceae, Burseraceae, and Myristicaceae (*op cit.*) contribute to the abundance of fruit.

Lipid-rich fruits formed the most abundant component of the food delivered. The coincidence of nesting with peak in lipid-rich fruit availability could be as a result of long-term co-evolutionary process (McKey 1975). The high lipid content of these fruits may be necessary to meet the requirements of the nesting, moulting, and growing birds (Snow 1981).

Protein, carbohydrate, and water is obtained from sugar-rich fruits (including figs) and animal matter, which supplement the lipid-rich diet of the nesting hornbills. Notably, the Malabar grey hornbill fed less on *Ficus* fruits (26%) than the great pied, oriental pied (*Anthracoceros coronatus*), and wreathed (*Aceros undulatus*) hornbills (Kannan and James 1997, Tsuji 1996). The smaller white-throated brown hornbill (*Ptilolaemus tickelli*), however, is shown to feed less on figs.

Smaller-sized hornbills are able to feed on a wider range of fruit and animal food, probably due to their smaller body size which enables them to access even the understorey shrub species, thus reducing the predominance of any one type of food. The Malabar grey hornbill consumes a greater variety of sugar-rich, particularly understorey fruits, as well as fruits of small trees and climbers, unlike the larger syntopic great pied hornbill which prefers large, canopy and emergent trees (Kannan 1994).

A wide range of food items are fed to the nest inmates. The kind of food delivered influenced the visitation rate, and the time spent at nest by the male. The time spent was significantly higher in the pre-hatching phase as there was a greater number of small fruits (both lipid- and sugar-rich fruits, i.e., 61% of all small fruits) delivered at the nest. The time spent at the nest decreased towards the end of the nesting period, when large fruits and animal food were brought for the inmates and delivered as a single item per visit. The visitation rate did not differ between the phases, though the number of fruits delivered per visit decreased in the post-hatching phase. This was probably compensated by the nutritive quality (lipid-rich fruits and animal food), and larger size of the food items delivered (eg. fruits of *Myristica* sp., *Beilschmedia* spp.). There was a drastic fall in the number of visits during the last few days of the nesting period. Welty (1982) proposed that the steady decline in feeding frequency may be a naturally evolved strategy of the parent to encourage the nearly-fledged young to leave the nest.

The differences in the food delivered during the nesting period can be explained by one or a combination of the following factors: (i) It could be related to the availability of fruits due to the usually high seasonal and synchronous fruiting of tree species bearing lipid-rich fruits (Snow 1981, Leighton and Leighton 1983, Kannan and James 1999), while the sugar-rich fruits are available all through the year. Community fruiting patterns in the study area were found to be largely determined by the trees producing lipid-rich fruits like Lauraceae, Annonaceae, which form a major proportion of tree species in the area (Kannan 1994). It was observed that certain fruits such as *Alseodaphne semecarpifolia*, *Litsea* sp., and *Persea macarantha*, which were common and abundant in the middens during the preliminary study in 1993, were absent in 1994. So, inter-annual differences in fruiting patterns, and intra-seasonal staggering in the fruiting patterns of the Lauraceae in the rainforests is likely to play a major role in the nesting and nesting success of the hornbills (Snow 1981, Leighton 1982, Leighton and Leighton 1983, Kannan and James 1999).

(ii) Another possibility is that the hornbill selects high quality nutritive food for the growing chicks in the post-hatching phase, feeding them largely lipid-rich fruits and animal matter, which may be of co-evolutionary significance. The increased delivery of animal food toward the end of the nesting season may reflect an increase in abundance of insect prey in the forest just after

the rains. The supplementation of high quality animal matter, however, coincides with the hatching of the chick and may provide the growing chick with essential nutrients.

(iii) Hornbills are known to be territorial, ranging between 3 to 30 km^2 (white-throated brown and great pied hornbills, respectively) depending on the size of the bird (Poonswad and Tsuji 1994). Seeds of some fruits (eg. *Filicium decipiens*, *Polyalthia* sp.) were found in the middens of only a few nests, probably because these fruiting trees were abundant in the territories of the hornbills inhabiting those nests.

Conclusion

The Western Ghats have been identified as one of the biodiversity hotspots in the world (Myers 1990, 1991). However, large scale deforestation for dam construction, agriculture and other developmental activities has resulted in the loss of over 40% forest cover in the last 70 years (Chattopadhyay 1985, Menon and Bawa 1997). This in turn has restricted the range of many species, including many endemics such as the Malabar grey hornbill. Hornbills play an important role in the dynamics of their habitats because of their specialised frugivorous habits (McKey 1975, Snow 1981, Leighton 1982) and as effective dispersers of many tree species (Kinnaird 1998, Whitney *et al.* 1998).

The Malabar grey hornbill, like other members of the family Bucerotidae, act as keystone species in the range of its distribution (Gilbert 1980). This endemic, specialist frugivore of the rainforest of the Western Ghats plays an important role in the dynamics of the moist evergreen forest it inhabits, dispersing the seeds of a few rare rainforest tree species. Conservation of their habitat is imperative as they have specialised feeding and nesting requirements (Mudappa and Kannan 1997).

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SOCIOECONOMIC TRANSITION AND WILDLIFE CONSERVATION IN THE INDIAN TRANS-HIMALAYA[1]

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Key words: management, protected area, policy, livestock, *Uncia uncia*, *Canis lupus*

The founding postulate of the preservationist conservation philosophy — that local human communities cause land degradation and biodiversity loss — is increasingly being questioned for its scientific validity. That this postulate may not hold in many cases is being used, *inter alia*, in support of calls for more inclusive conservation policies in developing countries. Such policies would allow, or even encourage, consumptive human use of natural resources within designated wildlife-protected areas. However, the latter approach again rests upon the assumption that local human communities and their impacts on natural resources are constant. The present paper questions this assumption using a case study from a hitherto isolated region of the Indian Trans-Himalaya. I describe the ongoing socio-economic flux in an agropastoral Buddhist community dependent upon the resources of a protected area, and the impacts of this transition on wildlife conservation. The analysis shows radical changes in the local economy and land use in the last decade, that ultimately proceed from extrinsic factors (market forces, changes in Government policy). Immediate conservation problems have proximately arisen from both extrinsic (uncontrolled tourism) as well as intrinsic (escalation of livestock stocking rate) changes. The analysis underscores the need for conservation policies to be sensitive to the transient nature of local human communities, even in seemingly isolated protected areas.

INTRODUCTION

The thrust of India's conservation policy has been preservationist, wherein emphasis has been placed on minimising or eliminating consumptive human uses within areas designated for protection of wildlife. Despite such an exclusionary official policy, more than 80 % of Indian wildlife reserves are inhabited by local human communities that continue to use the natural resources in them, albeit within state-imposed restrictions (Kothari *et al.* 1989). Such restrictions on traditional resource use following the creation of protected areas are responsible for local hostility and the absence of local support for conservation efforts (Kothari *et al.* 1995, Guha 1997, Saberwal 1997). This hostility gets further aggravated in the face of serious human-wildlife conflicts in many protected areas, and the subsequent bureaucratic apathy faced by the local people (Guha 1997, Mishra 1997a, Saberwal 1997, Saberwal *et al.* 1994) Not surprisingly then, as in many other developing countries (Prins 1992), the merits of the Indian preservationist approach are being increasingly questioned on social, economic, ethical, political, pragmatic and even ecological grounds. Critics have contended that the preservationist policy has been based on scientifically unsubstantiated assumptions that local human communities cause land degradation and the loss of biodiversity (Saberwal 1996, Guha 1997). There is an increasing call for 'rethinking conservation' and embracing a more inclusive policy, which, in theory, allows for biodiversity conservation alongside local human resource use (e.g. Kothari *et al.* 1995, Saberwal 1996). However, the latter thesis again rests upon an important yet unsubstantiated assumption that views local human communities, their life-styles,

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and the magnitude of their impacts, as static and immune to change (Mishra and Rawat 1998). It is this assumption that is questioned here. The aim is neither to denounce nor advocate the demands for 'democratic' multiple use policies; under the complex sociopolitical situations in most developing countries, strict adherence to either stand will prove counter-productive for wildlife conservation. The purpose of this paper, instead, is to show that irrespective of the official conservation policy (1) local human communities even in the remotest regions of the developing world are undergoing rapid social and land use transition, (2) this transition has potentially important consequences for wildlife conservation, and following from this, (3) conservation policies need to be extremely sensitive to these changes.

Focusing on three agropastoral Buddhist villages (80 households) dependent upon the resources of a protected area, this paper describes the ongoing socio-economic transition in the Spiti region (31° 42' to 32° 58' N lat. and 77° 21' to 78° 35' E long.) of the Indian Trans-Himalaya. Located close to the politically sensitive Sino-Indian border, in difficult mountainous terrain, Spiti remained a remote area with restricted geographical as well as administrative access until 1992. In this paper, I specifically document the socio-economic trends in the region over the last 25 years, and subsequently discuss their consequences for wildlife conservation. The urgent research and management inputs required for conservation both at the local and regional levels are also outlined.

Study Area

The Trans-Himalayan region includes the high altitude plateau of Tibet and the Tibetan marginal mountains, an area of over 2.6 million km^2. The *c.* 186,000 km^2 within India, despite its conservation significance, forms one of the least represented biogeographic zones in the Indian protected area network (Rodgers and Panwar 1988).

The Spiti region in the Trans-Himalayan Lahaul and Spiti dist. (Himachal Pradesh) spans an area of 12,210 km^2 in the catchment area of the Spiti river, with a human population of 9,591 (in 1991; Directorate of Economics and Statistics 1996) which is largely Buddhist (Kaushik 1993). Spiti had no wildlife reserves until the last decade. The establishment of the 675 km^2 Pin Valley National Park (31° 44' to 32° 11' N lat., and 77° 45' to 78° 06' E long.) in 1987, and the 1400 km^2 Kibber Wildlife Sanctuary (32° 5' to 32° 30' N lat. and 78° 1' to 78° 32' E long.) in 1992, has resulted in 17% of Spiti's land area being designated as wildlife reserve. The protected area boundaries, however, are only nominal, considering they were drawn around existing settlements and villages whose inhabitants continue using these areas for grazing, fuel and fodder collection.

Kibber Wildlife Sanctuary lies in the northern catchment of Spiti and is flanked by Ladakh to the north and Tibet to the east. The Sanctuary, like the rest of the Trans-Himalaya, lies in the rain shadow of the Greater Himalaya, and ranges in altitude from *c.* 3,600 m to 6,700 m above msl. Temperatures range between -30°C to 3°C in the winter, and between 1°C to 28°C in summer (Rana 1994). Vegetation in the area has been broadly classified as dry alpine steppe (Champion and Seth 1968). The Sanctuary is flanked by 13 villages along its southern boundary inhabited by an agropastoral Buddhist community, whose agricultural activities are restricted to the short growing season between May and September. Barley *Hordeum vulgare* and green pea *Pisum sativum* are the main crops. Livestock includes goat, sheep, cattle, yak, *dzomo* (female hybrid of cattle and yak), donkey and horse. Goat, cattle and *dzomo* are used for both milk and meat. Sheep are used for wool and yaks for ploughing, in

addition to meat. Donkeys are used as draught animals, and raised partly for trade. Horses, apart from being used for religious ceremonies, are raised mainly for trade (Mishra 1997a).

The mammalian fauna of the Sanctuary includes snow leopard *Uncia uncia*, wolf *Canis lupus*, red fox *Vulpes vulpes*, pale weasel *Mustela altaica*, stone marten *Martes foina*, Himalayan mouse hare *Ochotona* sp., bharal *Pseudois nayaur*, and ibex *Capra ibex.*

Methods

Unpublished archival records of the State Government were scrutinised (see Mishra 1997a for details of sources) for information relating to human population and past literacy rates, livestock population, and developmental changes in the region over the last 25 years. Of the 13 villages surrounding Kibber Wildlife Sanctuary, three, which together comprised 19% of the population living around the park, were selected as samples for the study (for details see Mishra 1997a). This included Kibber, the largest in the area (316 inhabitants), and two small villages nearby, Gete (36) and Tashigang (24). Structured interviews were conducted with at least one member from each household in the three villages, to obtain information regarding present family size and literacy, livestock and land holdings, and past and current agricultural practices. Human and livestock population growth rates (r) were calculated using the exponential growth curve equation ($N_t = N_0e^{rt}$ where N_t is the population at time t, N_0 is the starting population, and e the base of natural logarithms). Crop yield per unit area was obtained for different crops by interviewing two experienced farmers, and the lower limit of the reported range used to obtain a conservative estimate of crop production. Casual interviews and observations during the course of field work yielded information on tourism and its impacts.

Results

Human population and development

The human population in the thirteen villages bordering Kibber Wildlife Sanctuary increased only marginally (at an annual growth rate of 0.09%) between 1971 and 1991 (1985 people in 1991; data for 1996 not available). Likewise, between 1971 and 1996, the three study villages saw a total population increase of only 6.5%, an average annual growth rate of 0.25% (Mishra 1997a). Children <18 years comprise 49% of the present population of the study villages. Literacy rate has doubled (from 22% to 48%) in the last 25 years. Presently, 31% of the adult males (n = 91), and 26% of the adult females (n = 100) are literate. In the school-going age group (*c.* 5 to 18 years), there is 97% literacy (n = 127). Among other indicators of development, this period has seen an increase in the number of schools and the electrification of all three study villages (Table 1). Two of the three villages, Gete and Tashigang, which earlier had no roads, have been connected by motorable roads.

Agriculture

The number of people per unit of irrigated land has remained nearly constant over the last 25 years (Table 1), with the current average land holding per household at 1.13 ha. The cropping pattern, however, has changed in the last decade. Prior to 1986, agriculture was for subsistence.

Table 1
PATTERNS IN SOME INDICATORS OF DEVELOPMENT OVER THE LAST 25 YEARS IN THREE SAMPLED VILLAGES OF KIBBER WILDLIFE SANCTUARY

Indicator	1971	1996
No. of medical care centres	1	1
No. of post offices	1	1
No. of schools	1	4
Irrigated land (ha)	83	91*
People per ha irrigated land	4.2	4.1
No. of villages with electricity	0	3
No. of villages connected by motorable road	1	3

*in 1987

The main crops were barley and a local variety of pea (the latter largely for supplementing livestock feed), cultivated on two-thirds and one-third of the land holding respectively. Since 1986, however, one-third of the land holding is cultivated for green peas, one-third for barley, and the remaining is partly planted with local pea and partly left fallow. The entire harvest of green pea is sold as a cash crop. The estimated annual production of green pea per household is 2,587 kg, which translates into a per capita profit (corrected for transport costs) of US$ 210 per year (1994-95 conversion rate of 1 US$ = 31.4 Indian Rupees; World Bank 1996). The estimated annual production of barley per household is currently 1,294 kg.

This change in cropping pattern has significantly affected an age-old barter trade between the inhabitants of the study area and a semi-nomadic pastoral community, the *Changpa* of Ladakh. *Changpa* herders have been coming into Spiti for at least a few centuries (Kapadia 1996). They come in summer with their livestock (> 1,000 goat and sheep) when the high mountain passes (*c*. 5,600 m) become negotiable. The main trade involved barley, which earlier was in surplus, and was bartered with the *Changpa* largely in exchange for wool, salt and rugs. Owing to the replacement of barley with the commercially valuable green pea, and the resulting absence of surplus barley, the development of a market economy, and the improvement in transportation, communication, and supplies in Spiti, this trade is on the verge of breakdown. However, the trade continues for Spiti horses and donkeys, which are still in demand with the *Changpa*.

Livestock

The annual growth rate of livestock holdings in the study villages increased from 2.6% (between 1971 and 1987) to 3.5% after 1987 (up to 1996; Mishra 1997a). The growth rate of livestock throughout Spiti after 1987 was 3.2% (10,458 heads in 1988 to 11,881 heads in 1992). In the last 25 years, the ratio of livestock to human population in the study villages has increased from 1.85 (the year 1971, in Gete and Tashigang) to 2.80 (1996, in all three villages).

In terms of herd composition, Gete and Tashigang (data for Kibber for the year 1971 were not available) show an increase in all livestock species between 1971 and 1987, though the maximum increase was accounted for by goat and sheep (42%). After 1987, the number of donkeys and cow/*dzomo* declined, while the other species continued to increase (Table 2). In Kibber, the trend after 1987 was almost the same with all the species except cow/*dzomo* continuing to increase. Thus, in the last ten years, the population of cow/*dzomo* in all the sampled villages has declined marginally, while yak has increased more than threefold (Table 2). Goat and sheep again accounted for the maximum increase (57 %) during this period.

TABLE 2

LIVESTOCK POPULATION TRENDS OVER 25 YEARS IN THREE SAMPLED VILLAGES (DATA POOLED FOR THE VILLAGES GETE AND TASHIGANG) OF KIBBER WILDLIFE SANCTUARY

	Gete and Tashigang			Kibber village*	
Species	1971*	1987	1996	1987	1996
Yak	9	14	29	28	110
Cattle/ *dzomo*	13	32	28	113	98
Horse	6	11	18	34	57
Donkey	11	17	11	93	114
Sheep/ goat	76	101	137	322	452
Total	115	175	223	590	831

*data for 1971 were not available

Tourism

Prior to 1992, foreign nationals were not allowed in Spiti, and even non-domicile Indians needed to obtain special permits from the State Government to enter the region. With the relaxation of Government policy since 1992, there has been a sudden growth in tourism.

Kibber, one of the study villages, had three functional hotels and one more under construction when this study was conducted, as opposed to none before 1993. These small hotels (3-4 rooms), catering to both Indian and foreign tourists, are run by local villagers. Many villages of Spiti now have makeshift hotels. The tourist inflow is restricted to between June and September. Between June and August 1996, a hotel owner reported a net profit of *c.* US$ 637 (Chering Dorje, Kibber, *pers. comm.* 1996). Demand for local guides and donkeys by trekking tourists also causes a substantial inflow of money at the local level, which could not, however, be quantified.

Discussion

Human population

Most habitat change and biodiversity loss in developing countries has been attributed to socio-economic change in growing rural populations (Machlis 1992). The Indian population, 74% of which is rural, has indeed grown at an annual rate of 2.17% in the past two decades, yielding a current density of close to 300 per sq. km (Repetto 1994). In contrast, the absolute human density of Spiti is very low (0.78 per sq. km). The unusual absence of population growth could largely be a consequence of the relatively intact system of primogenitary inheritance over most of Spiti (and polyandry in one region) where the younger siblings become celibate monks (Mamgain 1975, Punjab Government 1994). The stable population size seems to have stabilised the pressure for fuelwood on the protected area. However, it is important to keep in mind that most of the area in Spiti is uninhabited due to its inhospitable cold desert mountainous environment. Consequently, 31% of Spiti's present population is concentrated in and around the two protected areas, and is dependent on them for grazing and fuelwood (Pin Valley has a human population of 1500 inside and around the National Park area; Mishra 1997b). A study estimates an annual per capita extraction of 217 kg of shrubs and dung (for fuel), and fodder (for winter supplemental feeding) by the resident population from Pin Valley (Bhatnagar 1996). It is also prudent to note that, faced with modernization, other trans-Himalayan Buddhist communities are undergoing rapid population growth following a breakdown of social population regulation mechanisms, and this might happen in Spiti as well (Goldstein 1981, Fox *et al.* 1994, Mishra and Humbert-Droz 1998).

Changes in agriculture and animal husbandry

The most significant socio-economic change in the region during the last decade has been the shift from a barter-based subsistence economy, to a market economy, resulting from, *inter alia*, changes in cropping pattern. The return per household from green pea harvest, the new cash crop, is almost as high as the average annual per capita income for Himachal Pradesh (US$ 248, 1994-95; World Bank 1996).

Along with agriculture, there is indication of commercialisation of animal husbandry as well (livestock trade was earlier restricted to barter with the *Changpa*). This is evidenced in the three-fold increase of yaks in the last decade, which are now partly being raised in the villages of Kibber Wildlife Sanctuary for selling in other areas of Spiti (Chhewang D. Zangpo, Pin Valley, *pers. comm.* 1996). This contrasts with other yak rearing communities in the Himalaya, where the yak population is known to be declining rapidly (Negi and Gadgil 1997, J.L. Fox *pers. comm.* 1996). Between 1988 and 1992, the yak population of Spiti increased from 786 to 897 heads.

Livestock of the study villages graze in the Sanctuary area nearly throughout the year, though their diet is supplemented by stall feeding in winter. This supplemental forage is partly

collected during the growing season from the Sanctuary area, and partly from the cropfields. In addition, the State Government has initiated a scheme to provide supplemental feed at subsidised rates. Given the present trend and the augmented ability to purchase supplemental feed, livestock holdings are likely to continue growing in the near future. The increasing livestock stocking rate seems to be intensifying the pressure on the protected area resources for fodder.

Escalating livestock stocking rate is a countrywide phenomenon in India, the last two censuses indicating a 1.2% annual growth rate (419 million in 1982 to 445 million in 1987). With 67% wildlife sanctuaries and 83% national parks subject to livestock grazing (Kothari *et al.*, 1989), the urgency for evaluating the impacts of livestock on wildlife resources is obvious. In Kibber, the increase in stocking rate (together with poor anti-predatory livestock management) seems to be the main reason behind the recent escalation in instances of livestock depredation by large carnivores (the snow leopard and the wolf; Mishra 1997a). Even now, livestock outnumber bharal, the dominant wild ungulate and natural prey of the wild carnivores, by an order of magnitude. To reduce this depredation, villagers have been killing the wolf, and elsewhere, I have expressed concern that persecution of the snow leopard is likely to begin unless specific research and management measures are undertaken to understand and reduce this conflict (Mishra 1997a).

At a broader level, there is a need for assessing the impact of grazing on plant communities and evaluating the forage relations between livestock and wild herbivores. The potential for regulating livestock stocking rates and range use to enhance conservation objectives has long been recognised (e.g., Anderson and Scherzinger 1975, Willms *et al.* 1980), and such studies are a pre-requisite to designing effective multiple-use management policies for Indian protected areas.

Uncontrolled tourism

Uncontrolled tourism in wildlife reserves has usually resulted in conservation problems (Budowski 1976, deGroot 1983, Kenchington 1989). Kibber presently lacks even a record of the number of tourists visiting the Sanctuary. With the sudden development of tourism, the age-old trade route between Kibber and Ladakh (used by the *Changpa*; *c.* 125 km) has now become a popular trekking route. This route passes along wetlands in Ladakh that are important breeding sites for water birds, including rare and threatened species (Mishra and Humbert-Droz 1998). A rather conspicuous impact of this tourism has been the pollution of this route with discarded garbage (including non-degradable metal cans and polythene), especially around about 15 camping sites.

In addition, Kibber Wildlife Sanctuary, like some other regions of Spiti, has deposits of nautiloid, balamnite, and ammonite fossils (Y.V. Bhatnagar, *pers. comm.* 1997). Locals reported that fossils were being removed from the area even before Spiti was opened to tourists. However, this was confined to geologists and amateur collectors. Tourism has now created a market for fossils, which is causing a rapid depletion of the fossil reserves of Kibber Wildlife Sanctuary and elsewhere in Spiti. Depending upon its size and quality, a fossil may fetch US$ 3 to US$ 15. I could not, however, assess the magnitude of this trade. The need for a culturally and ecologically well designed tourism plan for Spiti is apparent, and has already been expressed (Kaushik 1993, 1994).

Conclusions

Spiti remained geographically as well as politically remote and isolated until 1992, and the so far intact social population regulation mechanisms have kept the local human population under control. However, a rapid socio-economic transition is in progress,

exemplified by improvements in transportation, increase in literacy, changes in cropping pattern (the adoption of a cash crop), breakdown of barter trade, expansion of livestock holdings, and a sudden development of an unplanned tourism industry. This is ultimately driven by far-reaching extrinsic factors such as the influence of commercial markets and changes in Government policy. The transition from a subsistence (barter-based) economy to a market economy, and changes in land use in Kibber Wildlife Sanctuary, have resulted in conservation problems such as the escalation of human-wildlife conflict (livestock depredation by wild carnivores), increased pressure on the protected area for fodder, pollution, and the depletion of fossil reserves. These have proximately been brought about by intrinsic (escalating livestock stocking rates) as well as extrinsic (tourism) factors.

This paper joins a growing body of literature documenting the significant influence of market forces even in relatively remote regions of the developing world (e.g. Goldstein 1981, Goldstein and Beall 1989, Fox *et al.* 1994, Negi and Gadgil 1997, Mishra and Humbert-Droz 1998). It further shows that the resultant transition in socio-economy and landuse in local human communities can result in complex conservation problems. Conservation policies therefore, ought to bear in mind the transient nature of local human communities residing even in seemingly remote protected areas.

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AN ECOLOGICAL STUDY OF CROCODILES IN RUHUNA NATIONAL PARK, SRI LANKA[1]

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(*With three text-figures*)

Key words: Marsh crocodile, *Crocodylus palustris*, estuarine crocodile, *C. porosus*, Ruhuna National Park, basking, feeding, conservation

A study was carried out in Block I (140 sq. km) of the Ruhuna National Park (RNP) opportunistically from October 1991 to October 1994, in order to study the two species of crocodiles occurring in Sri Lanka, viz. *Crocodylus palustris* and *C. porosus*. A total of 341 sightings of the two species were made on 77 occasions, 307 sightings on *C. palustris* and 34 sightings on *C. porosus*. Among *C. palustris*, solitary animals made up most of the observations (55.8%) while pairs accounted for 13.0%. Of the 22 water-holes that were surveyed, 13 (59%) had only one crocodile. Although both species could be seen at any time of the day, the number basking increased with the increase in the ambient temperature, and peaked around noon. *C. porosus* basked alone, and *C. palustris* communally. The population structure consisted of 44% hatchlings, 6% juveniles, 24% subadults and 26% adults. Only adults of *C. porosus* were observed. Hatchling losses can be very high through predation by birds and mammals. Both species feed on a variety of food, ranging in size from aquatic insects and crustacea (in hatchlings) to fish, frogs, birds and large mammals (in adults). The minimum crude density values for *C. palustris* and *C. porosus* are estimated to be 0.72 and 0.07 animals per sq. km respectively. The populations of both species in Block I appear to be secure and viable.

INTRODUCTION

Of the 13 species of 'true' crocodiles (Subfamily: Crocodylinae) that are extant in the world, 8 species occur in Asia, of which 2 are found in Sri Lanka, namely the freshwater, or marsh crocodile, or mugger (*Crocodylus palustris*) and the saltwater or estuarine crocodile (*C. porosus*). While *C. palustris* is listed as 'vulnerable' by IUCN (Groombridge, 1993), *C. porosus* has been transferred to the 'low risk' category, given the tens of thousands known to be present in numerous localities across its geographical range. However, in Sri Lanka, given its low number and restricted distribution, *C. porosus* is more threatened than *C. palustris*. According to Whitaker and Whitaker (1989), "Sri Lanka has more mugger crocodiles than the rest of the subcontinent put together, mostly concentrated in the two national parks, Yala (=RNP) and Wilpattu." Even though this may not be strictly true now, it indicates the high number of mugger crocodiles still occurring in Sri Lanka. Both species found in Sri Lanka are listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Crocodiles were once plentiful in Sri Lanka. The man-made reservoirs or tanks in the Dry Zone were teeming with crocodiles (Baker

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1853; Tennent 1859; Hennessey 1949). But today, both species have declined in range and number as a result of poaching and loss of habitat. Crocodiles are almost confined to the first peneplain in Sri Lanka. They represent an excellent renewable natural resource and, therefore, their conservation can be made much easier if such a resource is used for the benefit of the people who share the land with them (Child, 1987). Unfortunately, crocodiles have a poor image in Sri Lanka. They are considered dangerous, and few would really regret their disappearance. The general public is unaware of the beneficial role played by crocodiles in wetlands. Legislation alone cannot save a species if the public is against its conservation. As Sale (1985) points out, a sound scientific understanding of a natural resource is fundamental to the management of that resource. Nowhere is this more true than in Sri Lanka, where the aims of crocodile management are straightforward preservation of the species within protected areas, with no interest in utilization despite the high economic value of the skin. So far, there has been no ecological study of crocodiles in Sri Lanka. Deraniyagala (1953) provides detailed information on the taxonomy, range and ecology of the two species of crocodile in Sri Lanka, while Whitaker and Whitaker (1979) carried out the first comprehensive survey of crocodiles in Sri Lanka. More recently, Porej (1997) studied the distribution of the two species along the south-western coast of Sri Lanka. An island-wide reassessment of their status was carried out by Santiapillai & de Silva (1998, under review).

Study Area

The study was carried out in Block I of the Ruhuna National Park, in southeast Sri Lanka in the low country Dry Zone (Fig.1). Block I is about 140 sq. km in extent, and is separated from the rest of the park by the Menik Ganga (= river) in the northeast. The vegetation of the park has been classified by Mueller-Dombois (1972) into three physiognomic categories: (a) forest (with at least 20% of crown biomass above 5m in height), (b) scrub (less than 20% of crown biomass above 5m), and (c) grassland or plains. The dominant forest trees are *Manilkara hexandra* (palu), *Drypetes sepiaria* (weera) in well drained soil, and *Limonia acidissima* (divul) and *Salvadora persica* (malithan) in poorly drained areas (Balasubramaniam *et al.*, 1980). The coastal region in Block I has numerous water-holes of varying size and salinity, surrounded by grasslands where the main species are *Eragrostis viscosa*, *Dactylotaenium aegyptium*, *Sporobolus diandrus*, *Echinochloa colonum*, *Setaria pallidifusca* and *Alloteropsis cimicina* (Balasubramaniam *et al.*, 1980). The fauna includes threatened species such as the Asian elephant *Elephas maximus* (E), leopard *Panthera pardus* (T), sloth bear *Ursus ursinus* (I), and water buffalo *Bubalus bubalis* (V). In addition, there are several herbivores: wild pig *Sus scrofa*, sambar *Cervus unicolor*, spotted deer *Axis axis* and mouse deer *Tragulus meminna*, which are potential prey species of the crocodiles. Other reptiles include the common monitor lizard *Varanus bengalensis*, cobra *Naja naja*, Russell's viper *Daboia russelli*. At least three species of sea turtles, the green *Chelonia mydas* (E), olive Ridley *Lepidochelys olivacea* (E) and leatherback *Dermochelys coriacea* (E), nest along the beach (Hewavisenthi, 1990). The most numerous crocodile in Ruhuna National Park is the marsh crocodile or mugger (*C. palustris*).

Methods

The study on crocodiles was incidental to a much larger study on the mammals of the Ruhuna National Park and was carried out in Block I opportunistically from October 1991 to October 1994. All observations were made from a vehicle, using a pair of 7 x 52 binoculars, from

Fig. 1: Map of Block I of Ruhuna National Park showing the waterholes

0600 to 1900 hr, during which time most of the water-holes in the park were visited. At every sighting of crocodiles, their number, location, habitat and behaviour were noted. Whenever possible, the species was identified based on field criteria such as the shape of the dorsal osteoderms — subquadrangular plates transversely sutured to one another in *C. palustris*, and ovoid and separated by skin in *C. porosus* (Deraniyagala, 1953). But this was not easy, for as Daniel (1983) points out, the two species are difficult to distinguish in the field. When the two species

are in water, they are almost impossible to tell apart. Besides, smaller individuals are difficult to distinguish in the field. Wherever possible, the length of the animals was estimated visually. Four categories were recognized: hatchlings (<0.5 m), juveniles (0.5-1.0 m), subadults (1.1-2.0 m), and adults (>2 m). The crocodiles were also monitored from 0600 to 1900 hrs at Buttuwa Wewa during the peak of the dry season in early October 1991, just prior to the northeast monsoon rains, to study their basking behaviour. An attempt was made to estimate the minimum number and density of crocodiles by taking into account the maximum number recorded from each waterhole within a sampling session (7-10 days).

Results

A total of 341 crocodiles (of both species) were recorded in 77 observations, of which 307 sightings were on *C. palustris* and 34 on *C. porosus*. Among *C. porosus*, solitary animals made up 55.8%, while pairs accounted for 13.0% (Fig. 2). The largest group seen during the survey consisted of 44 animals (39, *C. palustris* and 5, *C. porosus*), in the Buttuwa reservoir. It is likely that many of the pairs observed in Buttuwa reservoir are adult male and female marsh crocodiles. Of the 22 water-holes that were surveyed, 13 (59%) had only one crocodile (*C. palustris*) each. Crocodiles were observed to move from one waterhole to another during the dry season. As the dry season progresses from May to September, many of the smaller water-holes become bone dry, and the crocodiles (*C. palustris*), move either to large water-holes such as the Buttuwa Wewa, Wilapala Wewa, Heen Wewa and Katagamuwa tank, or concentrate along the Menik Ganga. In the dry season, one crocodile (*C. palustris*) was observed more than a kilometre from the nearest water-hole in the neighbouring Block II. At the peak of the drought, marsh crocodile numbers along

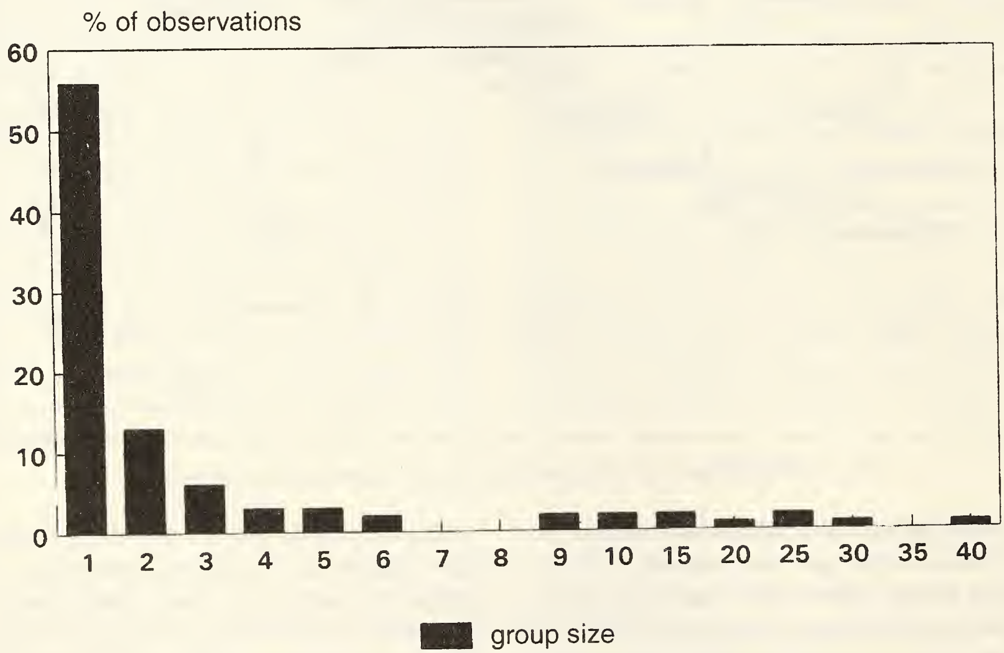

Fig. 2: Frequency of sighting of crocodile groupings of various sizes

the banks of Menik ganga can be as high as 35 animals per km. Furthermore, if the drought is prolonged, the Menik ganga mostly dries up, leaving scattered pools of water along the banks. These pools, which are no more than 0.5 m in depth, and a few sq. m in area, may be inhabited by up to 4 marsh crocodiles. The largest estuarine crocodile seen measured about 3.0 m at Diganwala, while the largest marsh crocodile was about 2.5 m at Gonalabba lagoon.

TABLE 1
SIZE AND COMPOSITION OF MARSH CROCODILES (*C. PALUSTRIS*) IN RNF (N = 50)

size class (m)	number	percentage	category
<0.5	22	44	hatchling
0.5-1.0	3	6	juvenile
1.0-2.0	12	24	subadult
>2.0	13	26	adult

When the maximum number observed in each waterhole within a sampling session (7-10 days) was taken into account, there were 101 marsh crocodiles and 10 estuarine crocodiles in Block I. This amounts to a minimum crude density of 0.72 per sq. km of *C. palustris*, and 0.07 per sq. km of *C. porosus* in Block I. Among *C. palustris*, 44% were hatchlings, 6% were juveniles, 24% subadults, while sexually mature animals made up 26% (Table 1). The observed *C. porosus* were all adults. However, the hatchlings and juveniles taken as *C. palustris* may have included some *C. porosus* as well, since these two species are difficult to distinguish in the field from a distance, especially when they are small. Crocodiles could not be sexed in the field.

Crocodiles were seen throughout much of the day, either in water, or basking on land. In Block I, both species were observed basking on the embankment of the reservoirs or on the banks of rivers and streams. The pattern of basking observed at Buttuwa Wewa was generally the same in both species (Fig. 3). The ambient temperature increased as the day progressed, and there was a substantial increase in the number

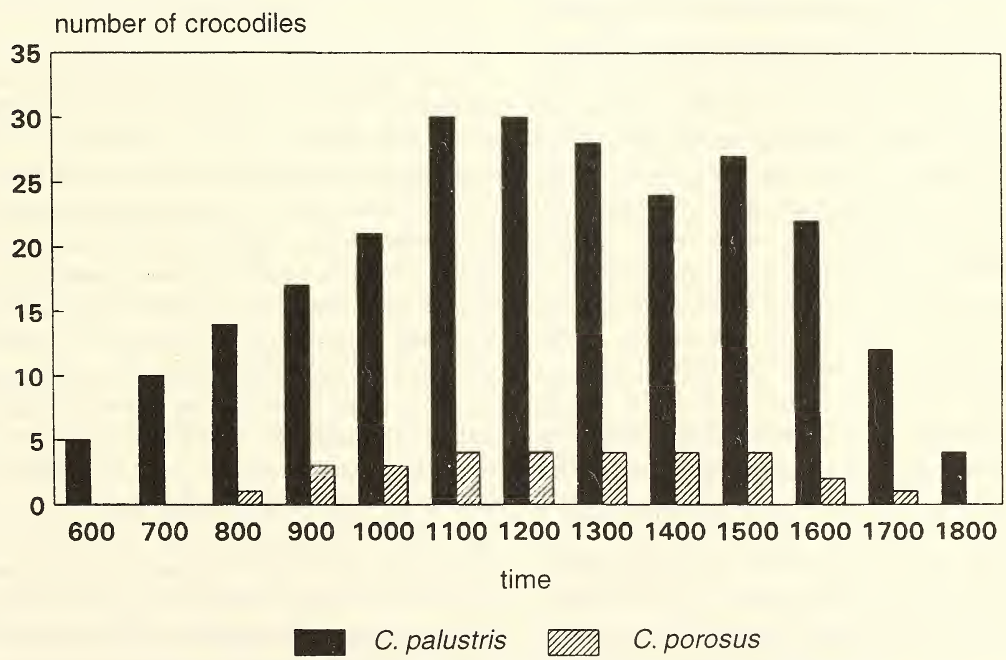

Fig. 3: Pattern of basking activity shown by both species of crocodile

of *C. palustris* observed basking, with the maximum number recorded from 1100 to 1200 hrs. A much smaller number of *C. porosus,* while showing a similar trend, were observed basking from 0800 hrs, reaching a peak from 1100 to 1500 hrs, and subsequently declining until 1700 hrs. Another behavioural difference that may help in the identification of species in the field concerns basking. Marsh crocodiles were seen basking communally, while estuarine crocodiles were never observed basking together. However, the estuarine crocodile was also seen basking in the company of marsh crocodiles. While basking, one *C. palustris* was observed defaecating, after which it moved its hind leg over the pile of faeces and shifted its hind parts a little away, then continued basking. Basking crocodiles varied in the length of time they kept their mouths open, the maximum period being 2 hrs.

Both species of crocodile were observed feeding on frogs, which are abundant in almost all the water-holes in Block I. In the dry season, frogs may form a substantial part of the crocodiles' diet at the smaller water-holes where there are no fish or crustaceans such as crabs or prawns, since the water-holes dry up. However, in the lagoons such as Gonalabba, Uraniya and larger water-holes at Heenwewa, Wilapala Wewa or Palatupana, into which *Tilapia* were introduced, crocodiles fed largely on such fish. Two marsh crocodiles were seen at night attacking a dead buffalo, in Uraniya plains. Marsh crocodiles were also observed feeding on the carcass of spotted deer, and sambar. In the present study, estuarine crocodiles were not observed feeding on carrion, although it is quite likely that they do. They were not observed doing so, though they were seen at night away from the water-holes. Marsh crocodiles were seen pulling the carcasses either from land or near the water's edge into water and eating them. Once the carcass is under water, it is out of reach of other scavengers such as jackal (*Canis aureus*) and wild pig (*Sus scrofa*). In Ruhuna National Park, crocodiles of both species catch most of their terrestrial prey near the edge of the water. Much of the feeding appears to take place at night.

Hatchling losses can be very high due to predation. In Block I, hatchlings were seen among the roots of *Rhizophora* trees in the mangroves at Buttuwa, where the prop-roots form a three dimensional mesh, which even some large wading birds find difficult to penetrate. The only birds large enough to attack hatchlings are the black-necked stork (*Ephippiorhynchus asiaticus*), lesser adjutant stork (*Leptoptilos javanicus*), spot-billed or grey pelican (*Pelecanus roseus*), and raptors such as crested hawk eagle (*Spizaetus cirrhatus*), crested serpent eagle (*Spilornis cheela*), brahminy kite (*Haliastur indus*) and white-bellied sea eagle (*Haliaeetus leucogaster*). According to Park officials, egg predation by jackal (*Canis aureus*), monitor lizard (*Varanus bengalensis*) and wild pig can be substantial.

Discussion

In addition to the crocodiles that were observed in Block I of RNP, another 150-200 marsh crocodiles were recorded from the Katagamuwa Wewa (Fauna International Trust, 1993; de Silva, pers. obs.), which lies just outside the northwest corner of Block I (Fig. 1). As these marsh crocodiles regularly move in and out of Block I, they could be considered a part of the crocodile population of Block I. If these crocodiles are also taken into account, then the minimum crude density of the marsh crocodile in Block I could be as high as 1.99-2.16 animals per sq. km. Marsh crocodiles live in groups, but male estuarine crocodiles, being aggressive and highly territorial, tend to live alone. Furthermore, in estuarine crocodiles, the large territorial males may service a number of females, and thus keep potential competitors at bay (Webb and Manolis, 1989). This may explain the movement of some

males far into the interior, away from the estuaries. The number of crocodiles inhabiting a particular waterhole depends not only on the productivity of the waterhole, but also on its size. Usually, large waterholes such as Wilapala Wewa and Buttuwa Wewa support relatively large numbers of crocodiles, in particular *C. palustris*, all year round.

In general, female crocodiles grow more slowly and reach maturity at a smaller size than males, which continue growing and usually exceed females in maximum size (Ross, 1998). According to Webb and Manolis (1989), in saltwater crocodiles, the females reach sexual maturity at the age of 12 years (2.3 m total length), while the males become sexually mature at the age of 16 years (3.4 m total length). But female marsh crocodiles of 6 years and 8 months of age (2.2 m) have also been known to reach sexual maturity in India (Whitaker and Whitaker, 1989).

As crocodiles cannot maintain a constant body temperature by physiological means, heating and cooling are of particulaı importance to them (Webb and Manolis, 1989). Crocodilians have a preferred body temperature of about 30-33°C, and to achieve this temperature range, they move to and fro between water and land. Basking crocodiles usually orient themselves in such a way as to get the maximum exposure to the sun. But as their body gets heated, they reduce the heat uptake by turning and facing the sun, and opening their mouth to cool the brain through evaporative cooling (Webb and Manolis, 1989). Crocodiles in general are very sluggish, and their short periods of activity are usually followed by long periods of inactivity. Wading birds were seen feeding quite close to the basking crocodiles.

Crocodiles are very effective aquatic predators. They are also opportunistic feeders, and catholic in their diet. Most wild crocodiles are known to be attracted to carrion (Webb and Manolis, 1989). In Katagamuwa tank, marsh crocodiles are known to feed communally on fish, when water is low (Fauna International Trust, 1993). Although game animals fall prey to crocodiles, such predation is unlikely to have a significant effect on their numbers. It is likely that the bulk of the crocodiles' food in the park consists of fish, frogs and water birds, which are most abundant the year round. As the dry season progresses, many of the water-holes dry up. Fish become concentrated in a few water-holes, which attract crocodiles from other areas. Crocodiles can go for months without feeding (Whitaker and Whitaker, 1989). They are known to feed on a variety of food items that range in size from freshwater mussels to water buffalo (Webb and Manolis, 1989). Their food changes with their size: beginning with aquatic insects, crustacea, small fish, and as they grow larger, vertebrates such as fish, turtles, birds and mammals (Ross, 1998). Much of the feeding appears nocturnal, for which they are well equipped with good eye sight. The retinal tapetum situated at the back of the eyeball is an image intensifier, allowing crocodiles to see better even in low light intensities (Webb and Manolis, 1989).

The predators on crocodile hatchlings, apart from those observed in Block I, include larger crocodiles, freshwater turtles, large predatory fish and python (Webb & Manolis, 1989). Although crocodiles lay many eggs, only 1 % of the hatchlings may survive to maturity, largely due to predation. The estuarine crocodile also suffers heavy losses when flash floods inundate estuaries where its mound nests are found.

Given the high number of crocodiles, especially marsh crocodiles, present in Block I of RNP, and the fact that these animals maintain genetic exchange with crocodiles from the rest of the Park, it is clear that both species of crocodile present in Block I constitute secure and viable populations. Factors such as desiccation of eggs during severe drought and avian predation on hatchlings appear to help regulate crocodile numbers in the Park.

Conservation and Management

There has never been any conservation programme designed specifically for crocodiles in Sri Lanka. While, they are being killed as vermin or poached for meat and skin outside the protected areas, their prospects for long-term survival appear good in a few protected areas such as the Ruhuna National Park in the southeast and the Wilpattu National Park in the northwest. The policy of allowing nature to follow its own course appears to have benefited crocodiles within these protected areas. Crocodiles being large predators, require very large areas of undisturbed wetlands to survive (Ross, 1998). Such areas are becoming increasingly difficult to find in Sri Lanka, as a result of the increase of its human population, currently estimated to be over 18 million. Therefore, protected areas appear to be the last refuge for wildlife. There have been no recent reports of crocodiles being poached within the Park, although several were killed outside.

The approach to management of crocodiles in the park is therefore a conservative one, in that the crocodile habitats are secure and remote from centres of high human population. So far, management measures have boosted the numbers of the crocodiles inside RNP. The crocodile, being an exceptionally adaptable predator, is able to survive on a broad spectrum of prey species. So the emphasis in crocodile conservation policy must be on maintaining a variety of prey, and preventing the pollution and destruction of the Park's wetlands. The national parks, however, remote from human population centres, are still prone to environmental disturbances outside their boundaries.

The crocodile is well adapted to respond to a "sanctuary strategy". There are good grounds to believe that it will increase in number under protection, which is by far easier, cheaper and more likely to be successful, than re-introduction. Local people strongly object to the translocation of a potentially dangerous predator such as the crocodile, to their neighbourhood. Law enforcement will become ineffective in the face of public hostility to crocodiles. The dissemination of factual information on crocodiles and their role in the ecosystem may help change the people's attitude.

In the final analysis, the survival of crocodiles is intimately linked with their acceptance by local people and the attitude of their politicians. What is needed is the widest possible acceptance of crocodiles as a renewable natural resource. Their conservation can be made easier, if this resource is used for the benefit of the people who share the land with them (Child, 1987). If crocodiles are properly managed, either in farms or as wild populations, they can become a considerable economic asset to the countries that contain them (Bellairs, 1987).

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SEXUAL HARASSMENT AMONG FEMALE LION-TAILED MACAQUES (*MACACA SILENUS*) IN THE WILD[1]

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(*With three text-figures*)

Key words: reproductive suppression, sexual swelling, *Macaca silenus*, mounting frequency

Adult female lion-tailed macaques often harass sexually interacting adult male and female members of the group. The extent of harassment and its implication for reproduction by females was studied in a group in the Anaimalai (presently Indira Gandhi) Wildlife Sanctuary, Tamil Nadu, India. Nearly 1560 hours of observation were made on the same group during nine months in 1979-80 and 15 months in 1982-84. A total of 577 sexual interactions between single adult male and females were recorded. Most of the sexual mountings occurred when the females had sexual swelling with a peak 2-4 days prior to deflation of the swelling. Most of the harassment was by females with sexual swelling. Harassment decreased the probability of mating taking place once a sexual interaction had been initiated (from 0.582 to 0.07). Aggressive harassment significantly reduced the duration of mating (from 9.12 secs to 6.16 secs), and thus probably prevented ejaculation. The percentage of sexual interactions that were harassed increased with the number of females with sexual swelling. Postponement of conception due to harassment might be a major reason for the absence of a synchrony in conceptions and births similar to that seen in sexual swelling soon after the summer amenorrhea. Sexual harassment is unlikely to serve as a behavioural means of population regulation. This is because fewer females show sexual swelling as the group becomes larger, probably due to increasing competition for food resources. The major reason for the occurrence of sexual harassment in the lion-tailed macaque might be competition among females for mating. This competition results from a high synchrony in sexual swelling among the females, the tendency for groups to have only one adult male, a high female to male (5:1) ratio, and multiple mount pattern in the male.

INTRODUCTION

Reproductive suppression of ovulating females occurs in some primates. In *Theropithecus gelada,* females actively disrupt each other's copulation (Mori, 1979). In the same species anovulatory cycles and premature termination of menstrual cycles and implantation occur in low ranking females from social stress due to harassment by high ranking females (Dunbar, 1980). Reproductive suppression from social stress also occurs in *Papio cynocephalus* (Wasser, 1983). In captivity, female rhesus monkeys could be prevented from mating by aggression from high ranking females (Keverne, 1983). Reproductive suppression of ovulating females has also been demonstrated in captive *Miopithecus talapoin* (Abbot *et al.*, 1986). In marmoset monkeys (*Callithrix jacchus*) ovulation by subordinate females is physiologically suppressed by the mere presence of the dominant females (Abbot, 1988).

Lion-tailed macaque, confined to the rain forests of the Western Ghats of South India, mostly live in one male units with a mean group size of 18-20 animals (Kumar, 1995a). The reproductive biology is characterized by a high sex ratio in favour of females (1:5), a conspicuous sexual swelling phase to which compulatory mountings are mostly confined, and a low birth rate (0.30/female year) compared to other macaques (Kumar 1987, 1995a). There is also a

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high degree of synchrony in the incidence of sexual swelling among the females. Harassment of the mating pair by others, especially by adult females, is frequent. This study examines the extent of harassment of matings pairs and its implication for reproduction by the females. Whether such harassment could play a population regulatory role is also discussed, since birth rate has been found to decrease with increasing group size (Kumar, 1995b).

Methods

The analysis is based primarily on data collected during an ecological study on one group in the Anaimalai (presently Indira Gandhi) Wildlife Sanctuary, Tamil Nadu State, from March 1979 to March 1980, and from December 1982 to March 1984. The group was located in Varagaliyar shola, about 25 km south of Top Slip, the Sanctuary headquarters. Varagaliyar shola is about 20 sq. km in area and is the largest of the rain forest fragments in the Sanctuary. This shola had five or six groups of lion-tailed macaque. The main study group had only one adult male during both the study periods. There was no subadult male in 1979-80, and one in 1982-84. The number of adult females varied from 5 in 1979-80 to 9 in 1982-84 (Table 1).

Table 1
COMPOSITION OF THE MAIN STUDY GROUP IN THE INDIRA GANDHI WILDLIFE SANCTUARY IN 1979-80 AND 1982-84

Year	Adult males	Subadult males	Adult females	Immatures	Total
Jan 1979	1	0	5	6	12
Mar 1980	1	0	5	9	15
Dec 1982	1	1	6	9	17
Mar 1984	1	1	9	12	23

Data on the incidence and duration of sexual cycles come from records on the sexual status (presence or absence of swelling) of females in the study group. These records were made during five to eight days of dawn to dusk observation of the group every month, and at least once in a week during the remaining part of the month. All sexual interactions between the adult male and females were recorded *ad libitum* during dawn to dusk observation, along with the sexual status of the female. The copulatory calls of the females (see below), given during more than 80% of the sexual mounting and audible up to 75 m, was used as an indicator of mounting. Mounting frequency/hour was estimated for each day by dividing the number of mountings (seen and heard) by the number of hours of observation. Only days with dawn to dusk observation were selected for analyses, since mounting showed a strong diurnal variation. Five to eight days of such observations were carried out each month between March 1979 and January 1980 (except for July and August when no data was collected) and again between December 1982 and February 1984 (except for January and February 1984 when only two days of observations were done each month). A total of 631 hours of *ad libitum* records were made in nine months in 1979-80 and 937 hours in 15 months in 1982-84. Besides the study group, six other groups were monitored at intervals of 30-40 days in 1979-80 and 1982-84. Data on seasonality of births were taken from these groups (see Kumar, 1987).

Results

Female Sexual Cycle: The female sexual cycle in the lion-tailed macaque is characterized by the cyclical appearance of sexual swelling in the perineal region and at the base of the tail which is conspicuous (Fooden, 1975). The swelling phase had a mean length of 14.1 days (range 8-19 days, n=7) and the non-swelling phase had a mean length of 16.4 days (range 6-25, n=7). The combined duration of these phases gave a mean cycle length of 30.5 days. More than 80% of the mountings by the adult male occurred

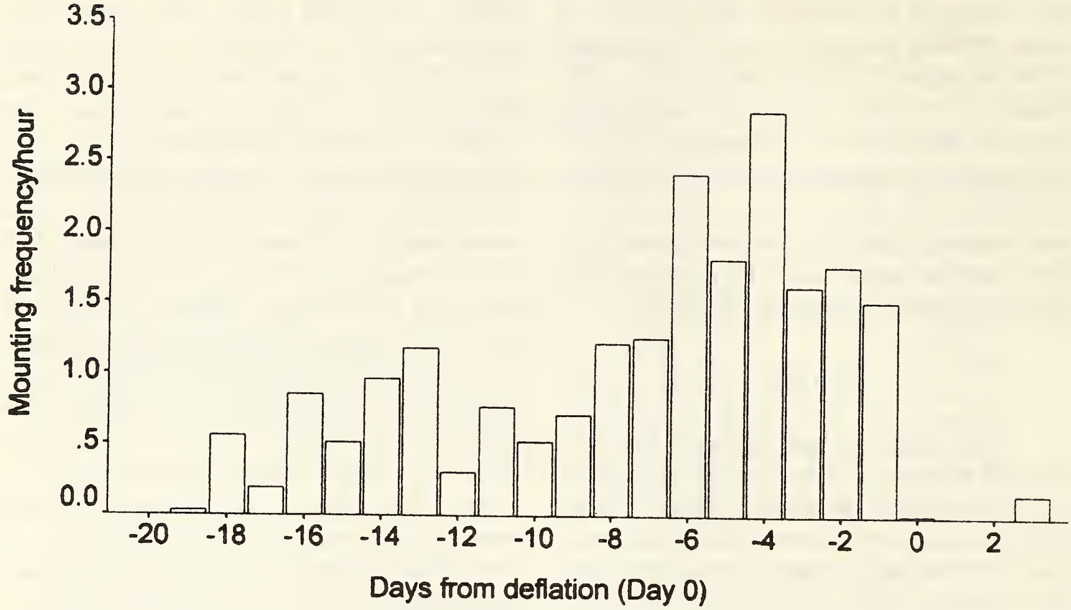

Fig. 1: Mounting frequency (per hour) by the adult male on successive days of a sexual swelling cycle of a female: mean for six sexual cycles. The sexual cycles were aligned by the day on which the swellings disappeared (day 0).

when the female had sexual swelling. Nearly 84% of these mountings were accompanied by copulatory calls of the females, compared to only 9.1% in the case of females without swelling ($\chi^2 = 24.9$, df=1, $p<0.001$). The mounting frequency started to increase 3 to 4 days before the appearance of the swelling and reached a peak (of about 3/hour) four days prior to its disappearance. It then dropped abruptly almost to zero on the last day of swelling (Fig. 1). The interval between the appearance of the swelling and peak sexual activity varied from 10 to 15 days, with a mean of 12.2 days (n=6).

When data from 1979-80 and 1982-84 were combined, swellings were seen in the study group in all months of the year except March and April. In May, swelling was seen only in the last week in 1979 and none in 1983 (Fig. 2). Although there are no systematic data from the other groups, no swellings were seen in them during March-May of 1979 and 1983. It appears, therefore, that there is a summer amenorrhea in the lion-tailed macaque in the months of March and April, probably extending to May. There was a synchrony of sexual cycles in the study group soon after the first cycle following the summer amenorrhea (Fig. 2). In 1979, the sexual cycle of two females started in the last week of May, and in June all the five females of the group had sexual cycles. The sexual cycle of two subadult females started only in September-October. All the four adult females which showed swelling in 1982-83 did so in synchrony in October 1983, one sexual cycle after the first cycle of the season. (Four of the remaining five females were in post-partum amenorrhea. The fifth, the oldest female of the group, did not show swelling in 1982-84). The cycle of the subadult female started only one month later.

Sexual Harassment: Sexual harassment consisted of activities by members of the group that apparently interfered with sexual

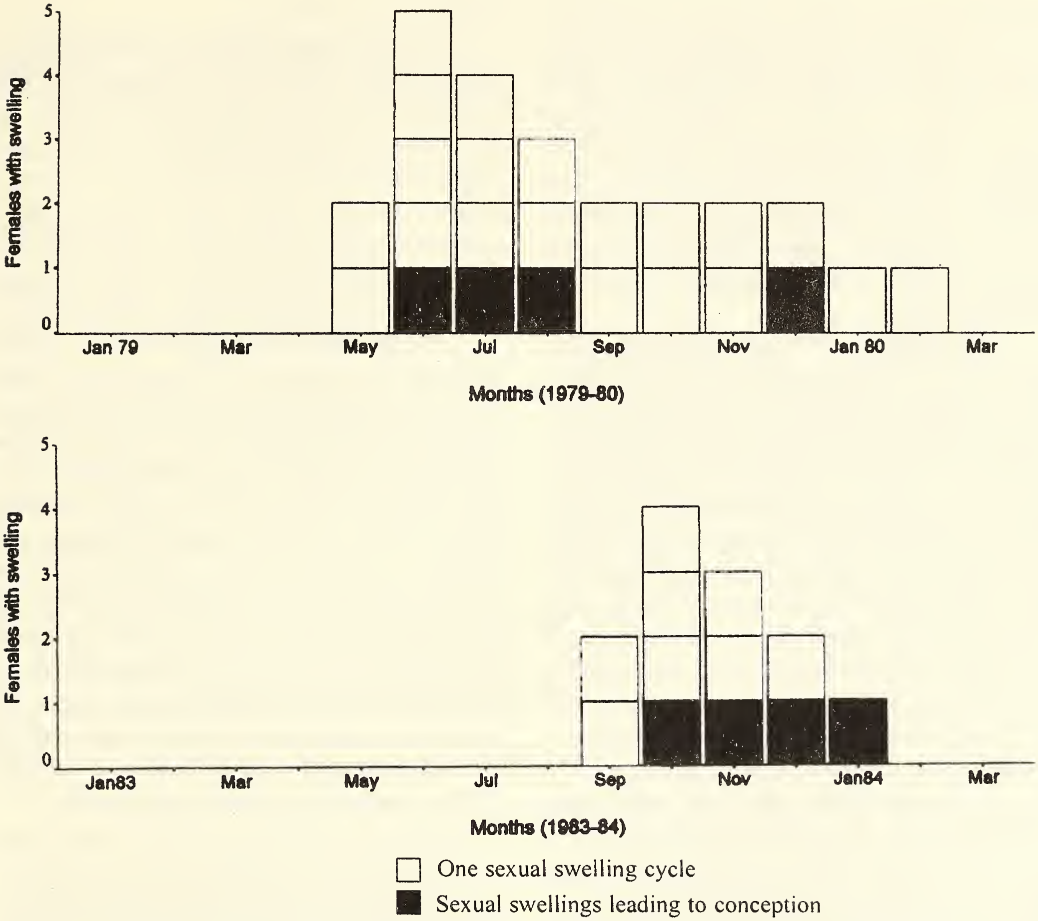

Fig. 2: The distribution of sexual cycles and conceptions in the adult females of the study group in 1970-80 and 1982-84.

interactions between adult male and female. Such interference occurred in 12.8% of the 577 sexual interactions observed. Interference occurred at the premounting stage (i.e. after the initiation of sexual interaction but before mounting) or at the mounting stage. Most of the interference were at the latter stage (70.3%).

Out of 74 harassments recorded, 23.0% were by infants and juveniles. These occurred mostly at the mounting stage, and consisted of rushing to the mating pair, and then moving about rapidly in short arcs about 2-3 m away (with tail-wagging and uttering '*uh uh*' sounds) until the mounting was over. Mountings involving females with and without sexual swellings were equally harassed by the immatures (Fisher exact test p=0.33). Moreover, mounting did not appear to discontinue as a result of such harassment.

Harassment by the subadult and adult females was related to the sexual status of the female interacting with the male. In 1982-84. 11.9% of the 270 sexual interactions involving females with swelling were harassed by other adult females, while none of the 69 mountings involving females without swelling were

harassed (χ^2=7.7, df=1, p<0.01). In 1979-80, 13.1% of the 145 sexual interactions involving females with swelling were harassed by other adult females as opposed to only 2.2% of 90 sexual interactions involving female without sexual swelling (χ^2=6.8, df=1, p<0.01). About 5.2% of the sexual interactions were harassed by the subadult and adult females at the pre-mounting stage and a further 12.1% at the mounting stage.

Harassment at the pre-mounting stage consisted of a female presenting to the adult male while another female was presenting, often between the male and the first female. Sometimes a female rushed to a presenting female with aggressive calls and chased it away from the male or physically prevented the male from mounting by pulling it by the tail or by standing in the way. Harassment at the premounting stage occasionally resulted in the redirection of mounting to the harasser (21.4%). More often it prevented mounting from taking place. The percentage of sexual initiations which ended in mounting when harassed by adult females (7.0%) was significantly lower than those which were not harassed (58.2%, χ^2=12.0, df=1, p<0.001).

Harassment at the mounting stage consisted of rushing to the pair with growls, and chasing and often physically attacking the female. Presenting in front of the mounted pair was also seen. Mounting of the harasser soon after mounting the harassed female occurred in 11.1% of the cases. When harassment was overtly aggressive the harassed female often ran or jumped away before the male had dismounted. Significantly fewer of the harassed mountings were accompanied by copulatory calls (63.3%) than those which were not harassed (83.6%, χ^2=4.6, df=1, p<0.05). Harassed mountings had a shorter duration (mean=7.75 secs, s.e=0.89, n=12), than normal mountings (mean=9.12 secs, s.e=0.35, n=95). However, duration of only those which were aggressively harassed (mean=6.16 secs. s.e=0.72, n=9) was significantly shorter (t-test, t=2.6, p<0.05).

In short, harassment (a) was mostly by adult females with sexual swelling; (b) was targeted at females with sexual swelling (c) drastically decreased the probability of mounting taking place after the initiations of a sexual interaction, from 0.582 to 0.07; (d) caused a premature termination of mounting and thus probably prevented ejaculation; and (e) redirected mounting from the harassed to the harasser.

Harassment and Synchrony in Sexual Swelling: The frequency of harassment varied with the number of females with swelling. At the pre-mounting stage, 1.3% of the sexual interactions were harassed with two females with swelling and 13.7% with four such females (χ^2=14.5, df=3, p<0.001, Table 2). Harassment at the mounting stage also increased with the number of females with swelling in the group, although the difference was not significant (χ^2=5.09, df=3, p>0.10). Harassment at the mounting stage was significantly more frequent when there were three females with swelling (33.3%) compared to when there was only one (7.3%, Fisher exact test, p=0.04).

TABLE 2
PERCENTAGE OF SEXUAL INTERACTIONS, HARASSED AT THE PREMOUNTING AND MOUNTING STAGES BY ADULT FEMALES, AND ESTIMATED PERCENTAGE OF MATING CURTAILED

Number of females with swelling	Sexual interactions seen	% harassed premount mount stage	% harassed mounting stage
0	69	0	0
1	108	1.9	7.3
2	75	1.3	14.3
3	14	7.1	33.3
4	73	13.7	11.6

The frequency of mounting by the male showed significant differences between days, depending on the number of females with swelling. (Kruskal-Wallis one-way analysis of variance (K-W test), χ^2=13.4, p<0.005, Table 3). However, it did not increase in proportion to the

TABLE 3
MOUNTING FREQUENCY (PER HOUR) BY THE ADULT MALE AND SUBADULT MALE WHEN THERE WERE 0 TO 4 FEMALES WITHSEXUAL SWELLING IN THE GROUP

		Number of females with swelling				
		0	1	2	3	4
Adult male	Mean	0.09	0.42	1.66	1.37	**1.53**
	Min.	0.00	0.00	1.14	0.27	1.24
	Max.	2.50	1.24	2.53	2.45	1.90
Subadult	Mean	0.04	0.04	0.23	0.30	**0.22**
Male	Min.	0.00	0.00	0.00	0.00	0.00
	Max.	1.50	0.10	0.38	0.82	0.36

number of females with swelling, but appeared to reach a plateau when there were two females with swelling. The single subadult male in the group in 1982-84 had a mating frequency that was considerably lower than that of the adult male, but seemed to increase as the number of females with swelling increased (Table 3). However, the duration of mounting was considerably shorter for the subadult male (often less than 5 secs), and also did not show the characteristic multiple mount pattern of the adult male.

Consequences of Harassment: If harassment significantly reduces the frequency of ejaculatory mating, this could result in a reduction in the chances of conception by female. This is particularly so if harassment is asymmetrically distributed among the females, for example due to social dominance. Dominance interactions were relatively few and occurred mainly on major feeding trees when visibility was poor. As a result, the dominance hierarchy of females in the main study group was not precisely known. Moreover, it was often impossible to identify the females because of the speed with which harassments occurred and poor visibility. Therefore, the reproductive consequences of harassment was examined indirectly. The distribution of conceptions and births in the study group was used to test whether females were less likely conceive when there were more than one female with swelling. If this is so, then conceptions and births would not show a synchrony similar to that shown by sexual swelling, but would be more evenly spread out across the months.

The date of births in the group during the study period were known. For these, the months of conception were estimated using a gestation period of 172 days (Lindburg and Lasley, 1985). Conceptions did not have a peak corresponding to that of sexual swelling at the beginning of the season (Fig. 1). Of the five females which had swellings in June 1979, only one conceived during that month. There were no data on sexual cycles in July and August, but only one each of four remaining females conceived in July and August. The cycles of the remaining two females continued in synchrony until one conceived in December. Since the second study ended before the births from the 1983-84 mating season (September 1983 to February 1984), stoppage of cycling by females was taken as indicating conception. Two females which showed swelling in September 1983 did so again in October, when the four females which showed sexual swelling during that mating season, did so in synchrony. The cycle of only one stopped after that month. The remaining three females showed swelling in November (along with a subadult female), but only two conceptions occurred. The cycle of the remaining adult female continued until December 1983. The subadult female's cycle continued until the end of the field study in February 1984.

Population regulation: Sexual harassment could potentially play a population regulatory role since the number of females that postpone conception, especially to the next reproductive year, could increase with group size. If this is the case, then the births in the larger groups should be more dispersed among the months. This was tested with data on births from the main study group and six other groups that were periodically monitored. The seven groups were divided into two group size classes (12-18 and

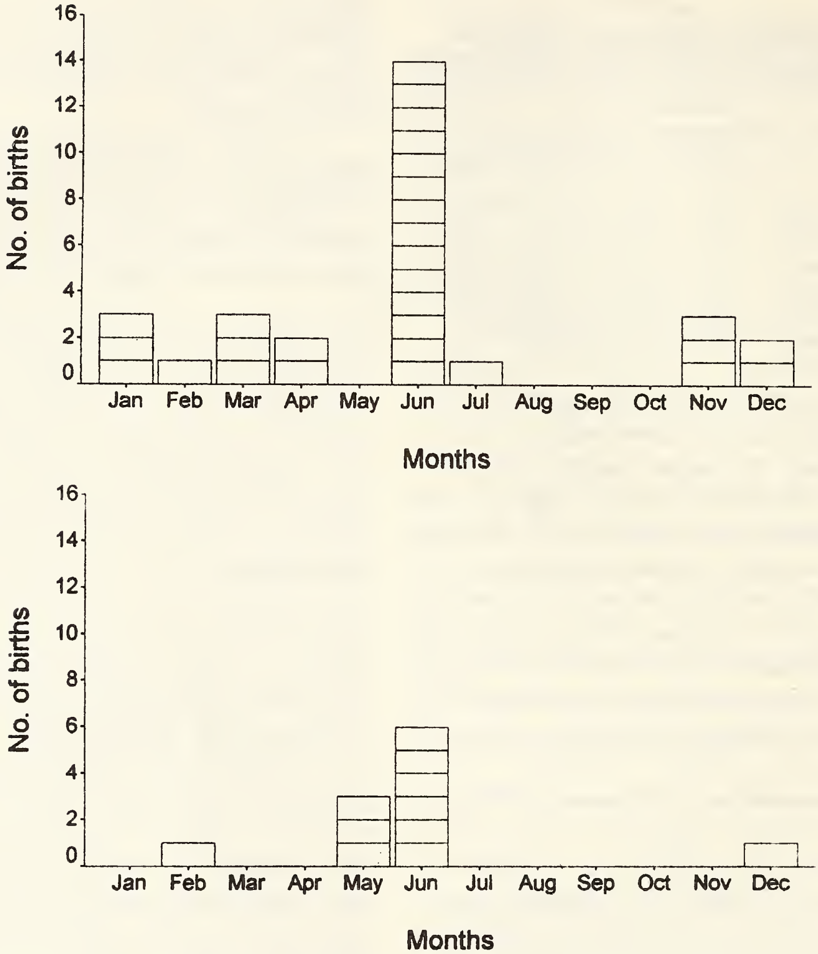

Fig. 3: The distribution of births in two group-size classes, 12-18 (above) and 19-28 (below). Each square represents one birth.

19-28) based on the mean group size during the study period (Fig. 3). Both the classes had the same mean birth date (Caughley 1977), June 15, but the coefficient of variation for the smaller class (205.0%) was nearly twice that of the larger class (112.2%). Thus, contrary to what was expected, births in the smaller groups were more dispersed through the year than the larger groups. It is also noteworthy that the main study group had a shorter mating season in 1983-84 when the group size was 17, compared to that in 1979-80 when the group size was 12 (Fig. 2).

Discussion

Sexual harassment by adult females probably occurs as a consequence of the high synchrony of sexual swelling among the females of a group, a high female/male ratio (5:1), and the tendency for the groups to be one-male units. These could lead to considerable sexual competition among the females. The multiple-mounting pattern of the male (Fooden, 1975; Kumar and Kurup, 1985) might also impose constraints on the mating potential of the male.

This competition could increase with the number of females in sexual synchrony. The extent to which harassment could affect the probability of conception would depend on the stage of the sexual cycle in relation to ovulation and the degree of asymmetry in the direction of harassment. Even though the frequency of mounting in the first week of swelling was highly variable even when there was only one sexually active female (Kumar, 1987), the peak between 2-5 days prior to deflation indicates that mountings at this stage of the cycle might be critical to conception. Thus, harassment in the last week of swelling could severely affect the probability of conception. At extreme asymmetry, in the direction of harassment, all the curtailed mountings could be of the low-ranking females. In addition, if harassments between females of different ranks differed in aggressiveness (for example, those by dominant females being more aggressive) mounting by the low-ranking females could be curtailed more than those of dominant females since aggressive harassments were more effective in curtailing mounting.

Birth rate in the lion-tailed macaques is a decreasing function of group size and the number of adult females in the group (Kumar, 1995b). Sexual harassment could lead to such an effect and thus serve as a population regulatory factor, if two conditions are met: i) the proportion of females coming into sexual synchrony during the mating season should be constant with group size, so that their absolute number would increase with group size; and ii) groups should be either one male units irrespective of group size, or when there is more than one male, only one of them is reproductively active during all the phases of the sexual cycle of the females. If these conditions are met, then the mating season should be more prolonged with increasing group size, as more females postpone conception. Therefore, births should be more dispersed in the larger groups and have a higher coefficient of variation. The limited data on the main study group shows that the mating season gets shorter, and not longer as predicted, as the group becomes larger. Also, contrary to the second prediction, births were relatively less dispersed in the larger groups than in the smaller groups. This was probably because of the violation of the above two conditions.

It is known that females do not ovulate until they reach a particular nutritional level (Frisch and McArthur 1974). Since resource competition increases with group size, it could be expected that the number of females able to build up sufficient nutritional reserves, so as to start ovulation, would decrease with increasing group size. There is no systematic data on the number of females coming into sexual cycle as a function of group size. In one large group with more than 25 members, which was regularly censused, not more than 4 of the 12 females were ever seen with sexual swelling on the same day. Since births in the larger groups were few, it was unlikely that other females were in post-partum amenorrhea. Moreover, although the group was seen almost every month in 1979, swellings were seen only in June and November-December (with 2 and 3-4 females respectively).

In addition, the number of adult and subadult males increase with group size (Kumar, 1987). No data was collected on the sexual behaviour of males in multi-male groups. The limited data on sexual behaviour of the subadult male of the study group indicate that mounting frequency of subadult males increased with the number of sexually active females in the group (Table 3). Even if mountings by the subadult male (and probably low ranking adult males of multi-male groups) are confined to the early follicular and luteal phases of the cycle, such mountings could significantly reduce the sexual competition between the females with overlapping sexual cycles. As a result, mountings by the adult male (or dominant male in multi-male groups), even if only confined to the late follicular phase, could be less harassed by other females which are in other phases of the cycle.

The short birth season in the larger groups might be, therefore, a cumulative function of (a) fewer females coming into sexual cycles in each season which in itself would significantly reduce female sexual competition and (b) more adult males in the larger groups which would further reduce female sexual competition. Thus, it appears unlikely that sexual harassment could be a population regulatory factor, in the small and large groups. In the former, in spite of female sexual competition (resulting from one male and several sexually active females), postponement of conception is expected to be only within the mating season. In the larger groups, on the other hand, fewer females ovulate in the mating season. It is possible that ovulating females are still sufficiently numerous in the medium sized one male groups, so that sexual competition could be high. A few females would be forced to postpone conception to the next mating season thus leading to/reproductive suppression.

Postponement of conception within the season could serve indirectly as a population regulatory factor. Increased mortality of infants born in late season has been reported; for example in *M. mulatta* (Drickammer, 1974) and in *A. palliatta* (Froelich *et al.*, 1981). Since postponement of conception is expected to increase with group size within the small to medium-size range, late season births and infant mortality could be expected to increase with group size within that range.

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SEASONAL CHANGES OF TROPICAL FOREST BIRDS IN THE SOUTHERN WESTERN GHATS[1]

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(*With seven text-figures*)

Key words: Seasonal changes, forest birds, Western Ghats, Kerala, India

A study was carried out in the tropical forests of Silent Valley and Mukkali in the Western Ghats, Kerala from May 1988 to April 1993, to elucidate the seasonal changes of bird communities in the two vegetation types. Abundance and density of birds were assessed, using variable width line transects each month. The highest populations, 609-1,892 /km^2 were found from December-April. Total number, monthly density and species richness of birds declined during monsoon. When compared, abundance and density of birds, observed in the evergreen forests was more (929 /km^2) than in moist deciduous forests (747 /km^2). However, bird population showed more stability in the moist deciduous forests. Except for two summers, significantly higher bird density was obtained in the evergreen forests during summer (1,074 /km^2). Bird species diversity was high during summer and low in monsoon in both the vegetation types. A direct negative relationship was also obtained between the rainfall, total number of birds, bird density and total number of bird species in the evergreen forests. Significant positive correlation was obtained between the temperature and bird community parameters in the evergreen forests, whereas rainfall and temperature showed no significant effect on the bird community in the tropical moist deciduous forests.

INTRODUCTION

Tropical forests support a stable population of birds in all seasons, whereas marked variations have been noted in temperate forests (Wright, 1970; Kricher, 1975). Seasonal variation of forest birds has been reported from several other countries (Anderson, 1972, Morrison *et al.* 1980, Pyke, 1984). No information, however, is available on the seasonal trends of tropical forest birds of the Western Ghats of South India. An attempt has been made to monitor the seasonal changes of bird communities in the tropical evergreen forests and the southern secondary moist mixed deciduous forest of Kerala. Birds of Kerala have been studied by Ali (1969), Ali and Ripley (1983a) and Ali and Ripley (1983b) earlier. Ecological studies were carried out at Silent Valley by Balagopalan (1990) and Balasubramanian (1990). Ramakrishnan (1983) studied the ecology of birds in the Malabar forests. Daniels (1989) and Daniels *et al.* (1990) reported many aspects of birds of the northern Western Ghats.

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STUDY AREA

Location and topography: The study areas, Silent Valley and Mukkali are located in Palakkad dist., Kerala State, between 11° 3' and 11° 13' N lat., and between 76° 25' and 76° 35' E long. They lie in the Western Ghats of south India and form part of the Nilgiri Biosphere Reserve (Fig. 1). After evaluating the entire area, two intensive study sites were selected: a tropical evergreen forest, Silent Valley, and a moist deciduous forest at Mukkali. The elevation of the study sites varied from 500 m to 1500 m above msl. The topography is undulating. According

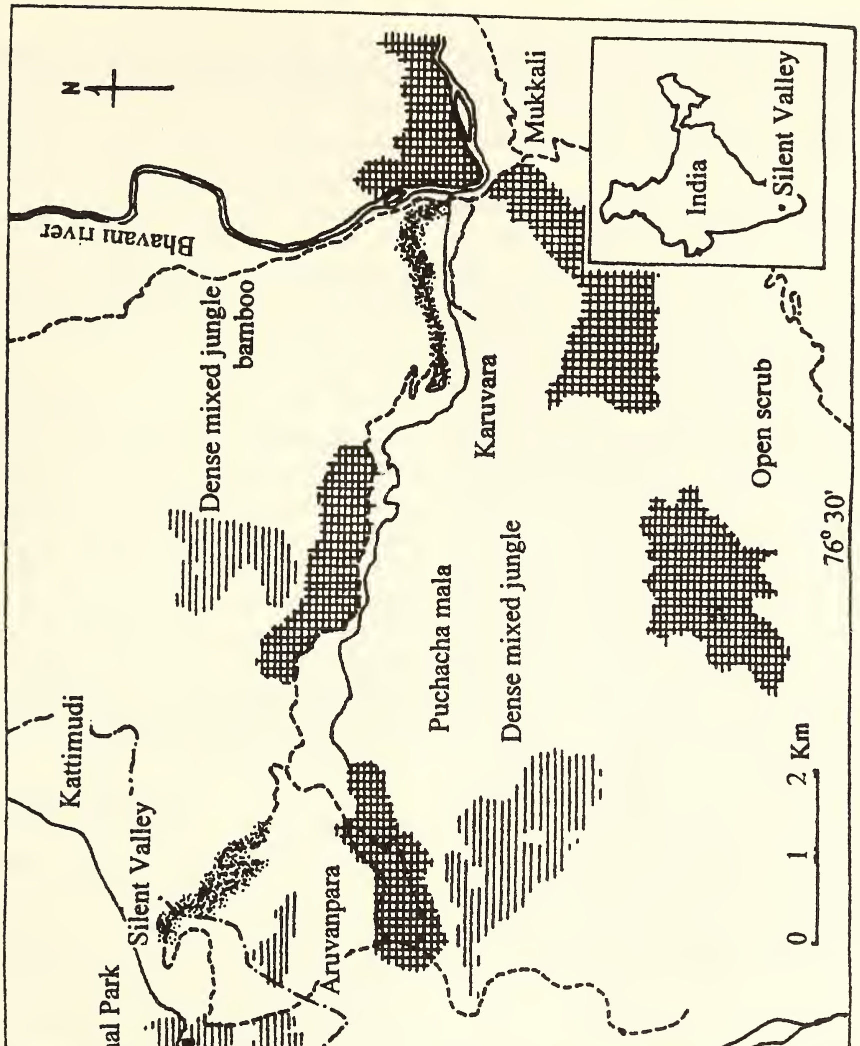

Fig. 1: Location of the study area

to Udvardy (1975), Silent Valley and Mukkali fall under the Malabar Rain Forest Realm. These two study sites are at a distance of about 20 km with a difference in elevation of 400 m between them.

Climate: There are two distinct seasons in the study area, monsoon starting from the end of May, up to mid-November, and the dry summer from December to April. Mukkali (4,227 mm/year) receives less rainfall compared to Silent Valley (5,096 mm/year). Heavy rainfall, 803 mm to 2,043 mm/month, was recorded at Silent Valley. From December to March, there is practically no rain. Temperature ranged from19°C to 22°C at Silent Valley and 21°C to 27°C at Mukkali.

Vegetation: A total of 966 species of angiosperms belonging to 559 genera and 134 families were recorded from Silent Valley and adjacent areas (Manilal, 1988). Pascal (1988) described the vegetation of the area as *Cullenia exarillata-Mesua ferrea-Palaquium ellipticum* type. It is characterised by the abundance of these three species, which may constitute about 80% of the large trees. Degraded areas and other vegetation types like grasslands are also common here. Vegetation of Mukkali is southern secondary moist mixed deciduous forest (Champion and Seth, 1968), degraded to some extent.

Methods

After considering all the available techniques, variable width line transect method described by Burnham *et al.* (1981) was adopted. Whenever a bird was spotted, it was identified up to the species level and details like the number of birds, perpendicular distance from the transect, height at which it is located in the canopy and habitat features were noted. Two line transects were selected, one at Silent Valley and the other at Mukkali; each transect was 4 km in length. The first transect covered evergreen forests and the second habitats like moist deciduous forests, rocky patches and fire burned moist deciduous forests. Census was started 30 minutes after sunrise in all the months. Transects were covered at a uniform speed. No census was done on days with very heavy rain and fog.

Two samples were collected from each area in a month. The second sample was started from the end of the first sample. A total of 150 samples were collected between May 1988 and 1993. No systematic data was collected on nocturnal birds. *All calls were considered as single individuals.* Perpendicular distances were measured approximately up to metres. To help distance assessment, known distances were measured and marked on trees using a Range Finder before the census. Abundance of birds in each month obtained from the census was used for analysis. Seasonal index of birds for each month was calculated using Time Series Analysis by the method of Simple Averages (Rao, 1983). The formula used is given below:

$$\text{Seasonal Index} = \frac{\text{Monthly average}}{\text{Sum of monthly averages}} \times 100$$

Analysis of variance was employed to find any significant difference existing in the total number of birds among the months. The Fourier Series Method was employed for calculating density from the ungrouped perpendicular distances from the transect. All the assumptions described by Burnham *et al.* (1981) were followed during the census. Students 't' test was applied to find out the significant difference in the number of birds between summer and monsoon. Diversity was calculated using Shannon-Wener Index ($H' = -\sum (pi \ln pi)$ with the program SPECDIVERS.BAS developed by Ludwig and Reynolds (1988). Spearman Rank Correlation was used to find out the correlation between climatic parameters and bird community parameters.

TABLE 1
SEASONAL INDEX OF BIRDS PRESENT IN EACH MONTH AT SILENT VALLEY AND MUKKALI

Area	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Silent Valley	114	109	88	81	95	54	58	59	119	101	136	153
Mukkali	113	92	131	89	84	113	73	87	116	99	133	70

RESULTS

PATTERNS OF CHANGE

Monthly variation: During September to February, more birds were present at the Silent Valley compared to the annual average of 100 (Table 1). In Mukkali, higher number than the annual average were observed during the months of January, March, September and November. Highest Seasonal Index (133) was obtained in November. Analysis of variance showed a significant difference in the total number of birds among the months at Silent Valley (F= 6.18; P= 0.01), whereas no significant difference was obtained at Mukkali (F= 1.95; P= 0.08).

Seasonal variation in a year: The total number, monthly density and species richness of birds at Silent Valley and Mukkali declined during monsoon and increased in the dry months (Table 2). No significant difference in total number was obtained between monsoon and summer at Silent Valley and Mukkali (Silent Valley 't'=1.63, P=0.14; Mukkali 't'=0.28, P=0.79). Species like the black bulbul (*Hypsipetes madagascariensis*), emerald dove(*Chalcophaps indica*) and the imperial pigeon (*Ducula badia*) were practically absent during monsoon at Silent Valley.

Seasonal change over the years: Total number of birds: Data were pooled into two seasons, monsoon and summer, to find out the seasonal differences in the total number of birds over the years. Chi-square test revealed a significant difference in the number of birds between the seasons at Silent Valley (Table 3). The highest number of birds per month (91) was observed in the 1991 summer and the lowest (53) in the monsoon of 1992. At Mukkali, there was no significant difference among seasons in the total number of birds. Significant difference in the number of birds per month between Silent Valley and Mukkali was observed during three summers. During these seasons, there were more birds at Silent Valley. But during the 1992 summer and monsoon, no significant difference in the number of birds was observed, both at Silent Valley and Mukkali.

TABLE 2
COMMUNITY PARAMETERS OF BIRDS RECORDED DURING TWO SEASONS (1988-1993)

Area		Monsoon season	Summer season
Silent Valley	No. of birds (mean)	70.00 (±28.63)	90.33 (±32.25)
	Density (birds/km²)	958.16 (±478.58)	1286.17 (±781.18)
	Species richness	28.33 (±6.87)	43.16 (±7.00)
Mukkali	No. of birds (mean)	60.67 (±12.61)	56.5 (±12.91)
	Density (birds/km²)	854.33 (±400.43)	707.00 (±285.36)
	Species richness	30.67 (±9.35)	39.17 (±10.23)

Standard Deviation is in parenthesis

TABLE 3
MEAN NUMBER OF BIRDS RECORDED PER MONTH IN DIFFERENT SEASONS AT SILENT VALLEY AND MUKKALI

Seasons	Silent Valley	Mukkali	Total	X^2	P=
Monsoon 1988	70	76	146	0.25	NS
Summer 1989	95	52	147	12.58	0.02
Monsoon 1990	74	48	122	5.50	0.02
Summer 1991	91	50	141	11.92	0.001
Monsoon 1992	53	67	120	1.63	NS
Summer 1992	83	70	153	1.10	NS
Summer 1993	89	59	148	6.08	0.02
Total	555	422			
X^2	16.36	11.83			
P =	0.02	NS			

NS= Not Significant

Species Richness: There is no significant difference in bird species richness between years in monsoon (χ^2=4.26; P=0.05) and summer (χ^2=8.92; P=0.05) at Silent Valley. But a significant difference was obtained between years in both seasons at Mukkali (Monsoon χ^2 =38.97; P=0.001, Summer χ^2= 14.64; P=0.001).

Density: Significant difference in density was obtained between seasons in different years at Silent Valley and Mukkali. The values for summer and monsoon showed a significant difference (Silent Valley: χ^2=62.25, P=0.05, df=1; Mukkali: χ^2=39.33, P=0.05, df=1). Bird density was high during summer, both at Silent Valley and Mukkali. Except for two summers, significantly higher bird density was observed at Silent Valley in summer (Table 4).

Diversity: Variations in the diversity of birds, based on Shannon-Wener diversity index, in different seasons at Silent Valley and Mukkali are given in Table 5. Diversity index showed high values in summer ($\overline{X}$=3.12, n=5) and lower during monsoon ($\overline{X}$=2.65, n=4), at Silent Valley and Mukkali (monsoon: $\overline{X}$=2.78, n=4 and summer: $\overline{X}$=3.14, n=5).

TABLE 4
SEASONAL VARIATION IN BIRD DENSITY AT SILENT VALLEY AND MUKKALI

Seasons	Density/sq. km			Mean density		
	Silent Valley	Mukkali	Total	Mean	X^2	P =
Monsoon 1988	1036 (3.23)	638 (5.01)	1674	837	94.63	0.001
Summer 1989	2123 (2.21)	1662 (7.72)	3785	1892.5	56.15	0.001
Monsoon 1990	685 (3.03)	401 (7.86)	1086	543	74.27	0.001
Summer 1991	741.4 (3.93)	370 (14.99)	1111.4	555.7	124.11	0.001
Monsoon 1992	493 (9.11)	792 (3.06)	1285	642.5	69.57	0.001
Summer 1992	823 (6.03)	757 (4.34)	1580	790	2.76	NS
Summer 1993	608 (10.91)	688 (5.61)	1296	648.0	4.94	NS
Total	6509.40	5308				
X^2	1976.52	1471.29				
P =	0.001	0.001				

NS= Not Significant; The values in the brackets denote coefficient of variation of the estimates.

Factors affecting the seasonal variation

Rainfall: A direct relationship was obtained between rainfall and number of birds, density and total number of bird species at Silent Valley. When rainfall increased, all of these three community parameters decreased, and vice versa (Figs. 2, 3 & 4). At Mukkali also, rainfall had its influence on bird community, but not in the same magnitude as that of Silent Valley (Figs. 5, 6 & 7).

At Silent Valley, significant negative correlation was obtained between the mean of monthly total rainfall (1988-1993) and number

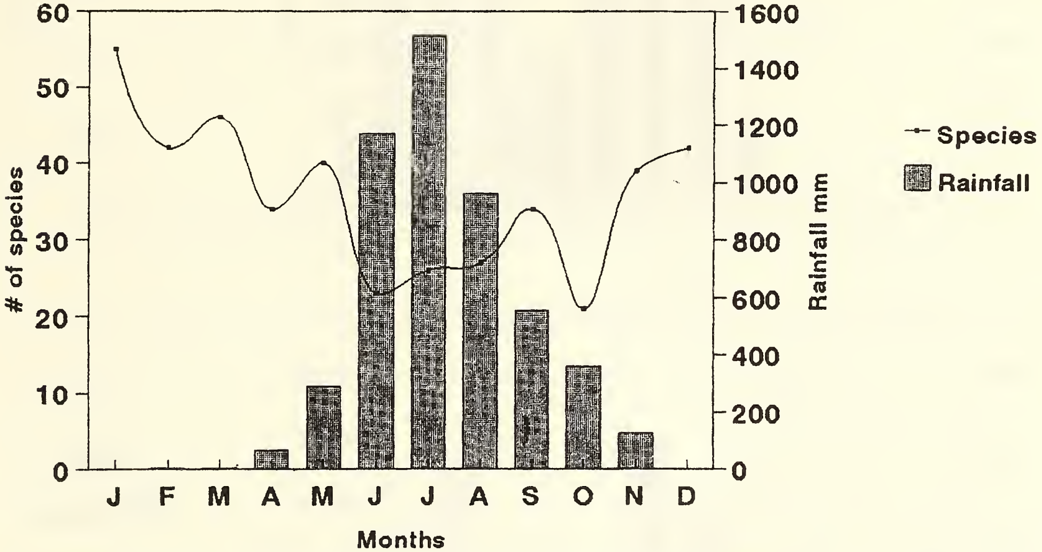

Fig. 2: Relation between rainfall and number of species at Silent Valley

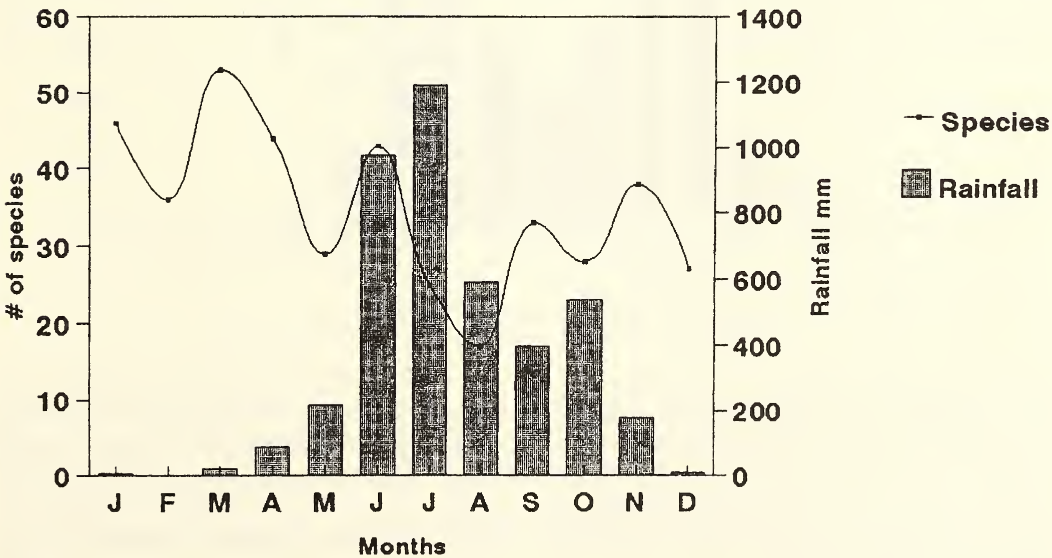

Fig. 3: Relation between rainfall and number of species at Mukkali

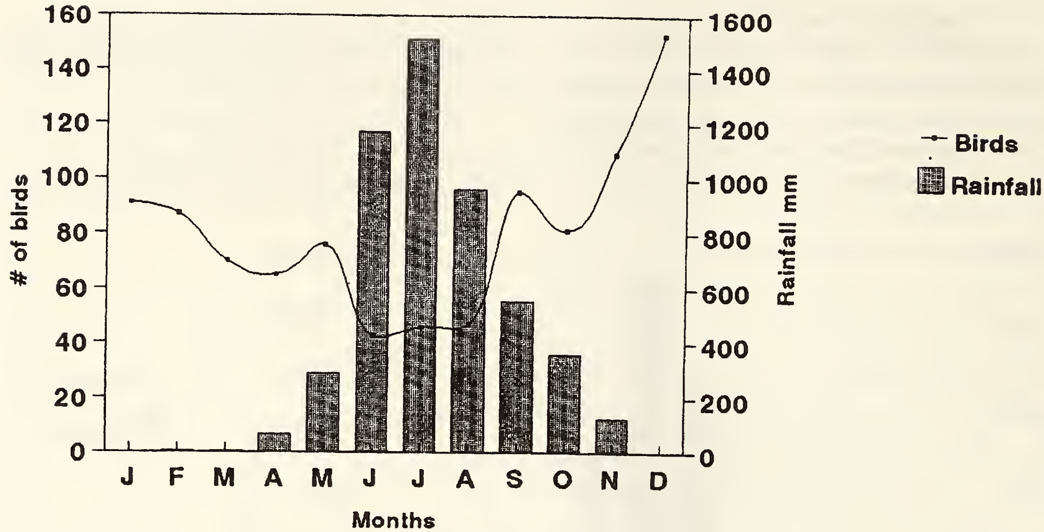

Fig. 4: Relation between rainfall and abundance of birds at Silent Valley

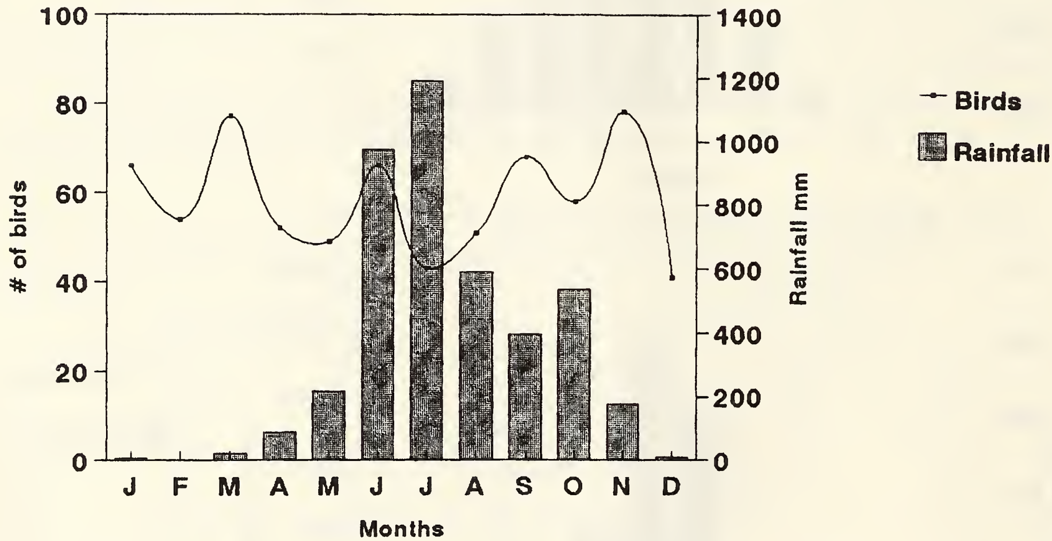

Fig. 5: Relation between rainfall and number of birds at Mukkali

of species in each month (r= -0.731, P= 0.01, n= 12). Significant correlation was also obtained between mean monthly rainfall and total number of birds in each month (r= -0.66, P= 0.05, n= 12). But there was no significant correlation between the density of birds in each month and rainfall (r= -0.45, P= 0.05, n= 12).

At Mukkali, no significant correlation was obtained between monthly rainfall and bird community parameters. Here, monthly rainfall showed negative correlation with the number of bird species (r= -0.41, P= 0.05, n= 12) and there was no significant correlation between monthly rainfall and the total number of birds (r= -0.21,

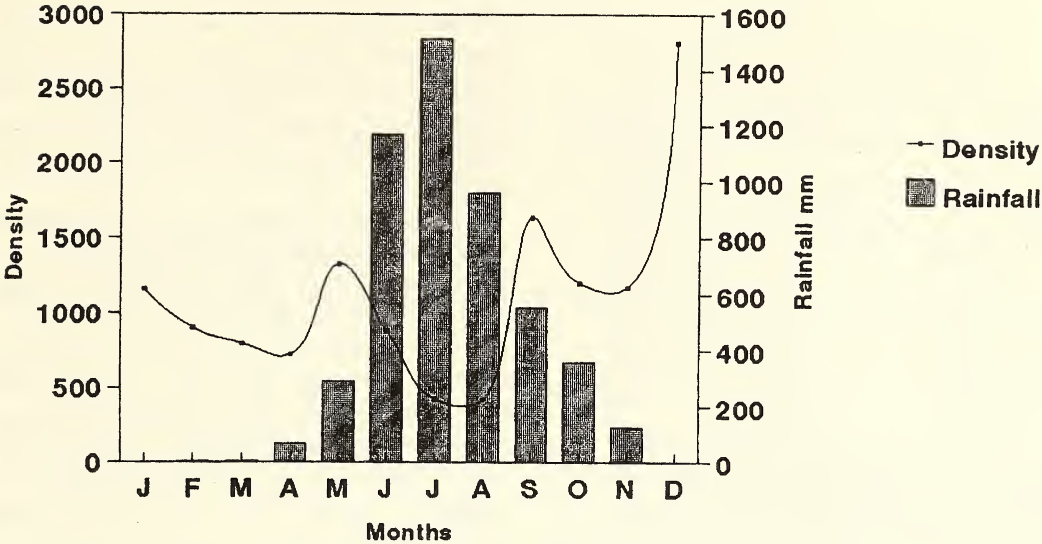

Fig. 6: Relation between rainfall and density of birds at Silent Valley

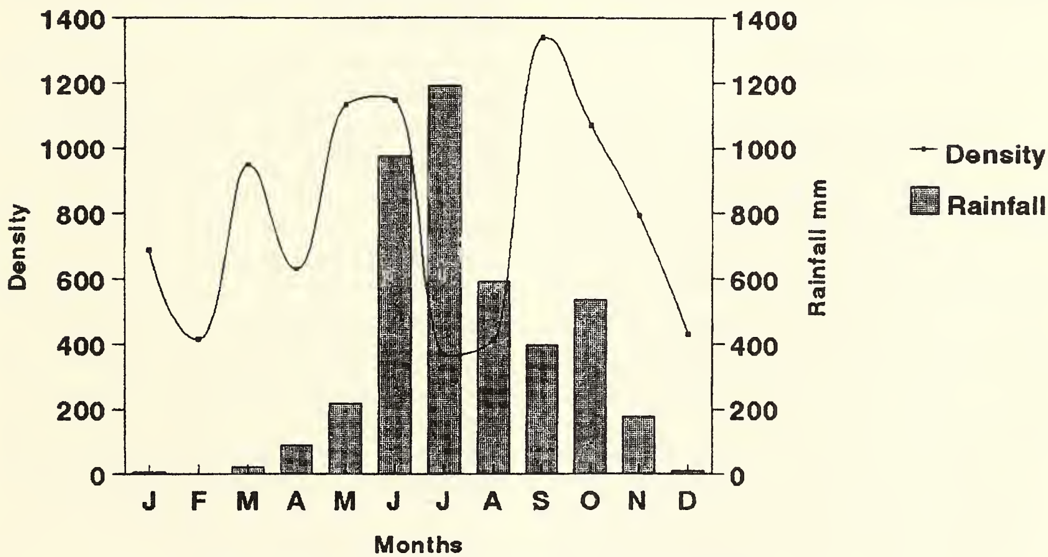

Fig. 7: Relation between rainfall and density of birds at Mukkali

P= 0.05, n=12) and their density (r= -0.06, P= 0.05, n= 12). This suggests that rainfall does not have any significant effect on the bird community at Mukkali.

Temperature: There was significant positive correlation between temperature and bird community parameters at Silent Valley. Number of species increased with increase in temperature (Coefficient of correlation r= 0.57, P= 0.05, n= 12). Similarly, total number of birds (r= 0.83, P= 0.001, n= 12) and their density (r= 0.62, P= 0.05, n= 12) showed an upward trend as the

TABLE 5
SEASONAL VARIATION IN DIVERSITY (H') AT SILENT VALLEY AND MUKKALI

Seasons	Silent Valley	Mukkali
Monsoon 1988	2.77	2.50
Monsoon 1989	2.38	2.63
Monsoon 1990	2.70	2.85
Monsoon 1992	2.74	3.13
Mean	2.65	2.78
Summer 1989	3.20	2.96
Summer 1990	3.01	2.95
Summer 1991	3.23	3.08
Summer 1992	3.29	3.46
Summer 1993	2.88	3.25
Mean	3.12	3.14

temperature increased during summer. At Mukkali, no such significant correlation was found (temperature and number of species $r= 0.21$, $P= 0.05$, $n= 12$; temperature and total number of birds $r= -0.08$, $P= 0.05$, $n= 12$).

DISCUSSION

Patterns of change: During monsoon, there was reduction in the number of birds both at Silent Valley and Mukkali. Birds appeared to move locally to avoid the unfavourable climate. Local movements in search of optimum habitats are possible because of the availability of other habitats in the vicinity as the tracts where the study was conducted were fragmented forest patches. Similar trends were reported from the tropical forests of other countries also. Variation in rainfall and soil moisture makes tropical bird fauna seasonal (Greenberg and Gradwohl, 1986). According to them, this is due to the influence of rainfall on phenological patterns of trees, which in turn affect the population trends of arthropods. Karr (1976) also showed the effect of high rainfall on the seasonal patterns of birds.

Higher numbers of birds were recorded during summer in two vegetation types. A greater abundance of birds was found at Silent Valley during summer than at Mukkali. Density of birds and their diversity indices were also higher for Silent Valley during summer, which can be attributed to the availability of more fruits at Silent Valley during summer. However, at Mukkali, the bird population showed much more stability.

Factors influencing the seasonal variations: Rainfall and temperature were the major factors influencing the abundance of birds at Silent Valley and Mukkali. Price (1979) who worked on the birds of Eastern Ghats also found a similar trend in annual cycles of bird fauna due to changes in rainfall. As mentioned earlier, a few species of birds like the yellowbrowed bulbul (*Hypsipetes indicus*) showed stability in population even in the fluctuating environment. This can be attributed to the resident nature of the species, coupled with its ability to feed on various food types like berries, drupes, nectar, spiders and insects.

Stiles (1978) had also shown that in tropical forests bird communities fluctuated in number as a response to the availability of food and climate changes. The relationship between food resources and bird diversity was also reported by Terborgh (1985). Even though tropical forest birds are considered sedentary, MacArthur (1972) has shown that seasonal movements are fundamental in many species as an adaptive strategy in varied forest habitats. This study also showed that rainfall and temperature influence the tropical evergreen forest bird community, whereas such climatic factors have little effect on birds of moist deciduous forests.

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PLODIA INTERPUNCTELLA (HUBNER) (PHYCITIDAE : LEPIDOPTERA) AS A POTENTIAL PEST OF DRY FRUITS[1]

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Key words: *Plodia interpunctella*, dry fruits, susceptibility, weight loss, development period, moisture content

Relative susceptibility of 12 types of dry fruits *viz.*, almond, apricot, cashewnut, chilgoza, coconut, date, fig, hazelnut, mulberry, pista, raisin and walnut and 10 varieties of pista procured from Iran i.e. Ebrahimi, Fandoghi, Gholam Rezaia, Jabbary, Kallenghoochi, Momtaz, O'hadi, Rezaia, Shasti and Wahedi to the attack of *Plodia interpunctella* (H.) has been studied for the first time.The results showed that cashewnut and pista were the most susceptible and date the least. Out of 10 pista varieties, the varieties Rezaia and Wahedi were the most resistant while the cultivars Fandoghi and Momtaz were the most susceptible. The index of susceptibility has been calculated on the basis of weight loss of fruits and development period and progeny of the pest.

INTRODUCTION

The Indian meal moth *Plodia interpunctella* (Hubner) (Phycitidae : Lepidoptera) is an important pest of stored cereals, legumes and dry fruits. The damage is caused by the larvae: besides consuming the product they also spoil it with their webbings and faecal matter, making it unfit for human consumption. A large number of studies have been made on its general biology. Hoppe (1981), Mbata (1987, 1990) and Stein (1990) studied the development pattern while food preference was studied by Lecato (1976). Observations on oviposition behaviour have been made by Mullen and Arbogast (1977), Mbata (1985, 1990) and Almasi *et al.*, (1987). Grant (1974), Grant and Brady (1975) and Grant (1976) studied the copulation while Grant (1974), Grant and Brady (1975), Ono (1981) and Rangaswamy (1985) made observations on the role of pheromones. The diapause behaviour has been studied by Bell and Walker (1973) and Bell (1976a, 1976b). However, only a few dry fruits have been tested as hosts of this pest. Myers (1928) studied the relative preference of the pest for a few dry fruits. Hamlin *et al.*, (1931), Simmons (1931) and William (1964) observed development in some dry fruits and cereals. Mullen and Arbogast (1977) studied oviposition on peanuts and dates while Mbata and Osuji (1983) studied the development in whole and cracked groundnuts.

The present communication deals with the relative susceptibility and extent of damage to 12 dry fruits and 10 varieties of pista, to assess the potential of *P. interpunctella* (Hubner) as a pest of stored dry fruit.

MATERIAL AND METHODS

Adults of *Plodia interpunctella* (H.) used in the present study were taken from stock cultures raised in the laboratory from small samples collected from Delhi and Chandigarh. The cultures were maintained on different foods stored in an electric incubator fixed at 30 ± 1° C and 75-85% R.H. The foods used for stock cultures as well as those selected for different experiments were sterilized at 50° C for two hours in order to eliminate any parasites or other microorganisms. The twelve selected dry fruits were *Prunus amygdalus* Batsch almond, *Prunus armeniaca* L. apricot, *Anacardium occidentale* L. cashewnut, *Pinus gerardiana* chilgoza, *Cocos nucifera* L. coconut, *Phoenix dactylifera* L. date, *Ficus glomerata* fig, *Corylus* spp. hazelnut, *Morus nigra* L. mulberry, *Pistacia vera* L. pista, *Vitis vinifera* L. raisin and *Juglans regia* L. walnut. The susceptibility index of different dry

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fruits was studied out by keeping ten three-day old eggs mixed with 2 gm of nuts. Three replications were kept in each case.

The samples were reweighed after emergence to determine the loss of weight due to consumption by the larvae. The moisture content of the samples was also calculated at the beginning and the end of the experiment and loss/increase in weight due to moisture variation was considered while calculating actual weight loss.

The percentage weight loss due to moisture content variations has been calculated by using the following relationship given by Jamieson (1970).

$$G = \frac{100\,(M_2 - M_1)}{100 - M_2}$$

Where M_1 = Initial moisture content percentage wet basis.

M_2 = Final moisture content percentage wet basis.

Knowing the value of G, the loss or gain in weight due to variation in moisture content (d) can be calculated as under, and necessary correction in weight loss of the food made.

$$d = \frac{G \times W_1}{100}$$

Where W_1 = Observed weight loss of the food.

G = Loss or gain percentage in weight due to moisture content variation.

The data obtained were subjected to statistical analysis.

Results and Discussion

The relative susceptibility of twelve types of dry fruits was calculated on the basis of food consumed, the number of adults emerged, duration of developmental period and weight loss of the fruits.

The results given in Table 1 showed that amount of different foods consumed by the larvae varied greatly, the largest amount being consumed in mulberry (1.816 gm) and the least in the case of coconut (0.004 gm).

Appreciable differences have also been noted in the average development period. Pista registered the shortest development period of 31.71 days, whereas, date showed the longest development period of 104.25 days. However, Hamlin *et al.* (1931) observed more rapid development of larvae on figs among three fruits namely raisins, prunes and figs tested by them. The progeny produced was maximum in pista, walnut, cashewnut and almond, while other fruits produced comparatively much less progeny. The

Table 1

WEIGHT LOSS OF 12 DRY FRUITS DUE TO THE ATTACK OF *PLODIA INTERPUNCTELLA* (H.)

(based on three observations)

Food	Initial Weight of food mean (gm)	Final Weight of food mean (gm)	Moisture Content M_1	Moisture Content M_2	Weight loss	Mean % age weight loss	Corrected mean % age weight loss
Mulberry	2	0.184	8.96	7.326	1.816	90.80	90.768
Fig	2	0.593	10.32	9.949	1.407	70.35	70.345
Cashewnut	2	1.149	4.38	3.307	0.851	42.55	42.541
Almond	2	1.248	3.82	3.410	0.752	37.60	37.597
Walnut	2	1.449	3.40	2.208	0.551	27.55	27.544
Pista	2	1.485	3.34	2.828	0.515	25.75	25.748
Raisin	2	1.497	12.12	6.479	0.503	25.15	25.120
Hazelnut	2	1.550	3.46	2.387	0.450	22.50	22.496
Date	2	1.713	9.26	7.764	0.287	14.35	14.346
Apricot	2	1.862	17.54	14.607	0.138	6.90	6.896
Coconut	2	1.996	2.98	2.550	0.004	0.20	0.200
Chilgoza	2	Nil	Nil	Nil	Nil	Nil	Nil

larvae failed to survive on apricot, coconut and chilgoza as they do not get sufficient nutrition to reach maturity. In fact, the larvae did consume some food in the case of apricot and coconut but died before reaching the pupal stage. In the case of chilgoza, on the contrary, the larvae did not consume any food.

The relative suitability of different foods was also determined with the help of the formula Log eY/T, given by Osuji (1976), where Y is the number of progeny, T is the time taken by 50% of the adults to emerge and e is a constant with a value of 2.303 (Table 2). Pista, walnut and hazelnut, with a suitability index value of 1.743, 1.590 and 1.393, were the most suitable food while date with an index value of 0.085 was the least suitable food.

The relative susceptibility of various foods can be judged by combining the amount of food consumed with the index of suitability (Table 3). Cashewnut and pista with susceptibility index values of 49.773 and 44.878 respectively, were the most susceptible foods whereas date with the index value of 1.219 was the least susceptible food.

Table 2

RELATIVE SUITABILITY OF 12 DRY FRUITS TO THE ATTACK BY *PLODIA INTERPUNCTELLA* (H.)

(based on three replications of 10 eggs each)

Food	Progeny Y	(Average) Development period (T_{50} days)	Index of suitability $Log_e\ Y/T_{50}$
Pista	24	31.71	1.743
Walnut	25	36.20	1.590
Hazelnut	21	34.71	1.393
Cashewnut	25	49.20	1.170
Almond	24	49.04	1.127
Mulberry	14	81.21	0.397
Fig	8	101.38	0.181
Raisin	5	94.60	0.121
Date	4	104.25	0.085
Apricot	Nil	Nil	Nil
Coconut	Nil	Nil	Nil
Chilgoza	Nil	Nil	Nil

Log_e = 2.303 (constant)
T_{50} = Time taken by 50% of the adults to emerge.

It is clear from the data in Tables 2 and 3 that the order of relative suitability and relative susceptibility of the foods was different. This is so because cashewnut undergoes maximum weight loss though the development period on this food is long. It is the duration of the development period that pushes the cashewnut at number 4 in term of suitability index. However, maximum weight loss by cashewnut pushes its susceptibility index to number 1. There is little difference in the two indices of pista and date which occupy the same order in the lists of both indices.

Table 3

RELATIVE SUSCEPTIBILITY OF 12 DRY FRUITS TO THE ATTACK BY *PLODIA INTERPUNCTELLA* (H.)

Food	Suitability index value (a)	Corrected mean % age of weight loss (b)	Susceptibility index value (axb)
Cashewnut	1.170	42.541	49.773
Pista	1.743	25.748	44.879
Walnut	1.590	27.544	43.795
Almond	1.127	37.597	42.372
Mulberry	0.397	90.768	36.035
Hazelnut	1.393	22.496	31.337
Fig	0.181	70.345	12.732
Raisin	0.121	25.120	3.039
Date	0.085	14.346	1.219
Apricot	Nil	6.896	Nil
Coconut	Nil	0.200	Nil
Chilgoza	Nil	Nil	Nil

The resistance among ten cultivars of pista procured from Tehran Agriculture University was tested on the same pattern as followed for different fruits and susceptibility index was calculated in the same manner. The obtained results are give in Tables 4, 5 and 6.

Table 4 reveals that varieties 'GH' and 'WA' underwent a minimum weight loss of 0.439 gm and 0.465 gm respectively whereas, 'MO' underwent a maximum weight loss of 0.660 gm.

The progeny from 30 eggs on each food varied from 20 to 28 and the developmental period differed from 22.5 to 26.83 days (Table 5).

TABLE 4
WEIGHT LOSS OF TEN VARIETIES OF PISTA DUE TO THE ATTACK OF *PLODIA INTERPUNCTELLA* (H.)

(based on three observations)

Food	Initial Weight of food mean (gm)	Final Weight of food mean (gm)	Moisture Content M_1	Moisture Content M_2	Weight loss	Mean % age weight loss	Corrected mean % age weight loss
'MO'	2	1.340	4.380	4.029	0.660	33.000	32.998
'FA'	2	1.363	4.600	4.400	0.637	31.850	31.849
'KA'	2	1.406	4.420	4.196	0.594	29.700	29.699
'JA'	2	1.431	4.160	3.913	0.569	28.450	28.449
'EB'	2	1.433	4.100	3.698	0.567	28.350	28.348
'SH'	2	1.471	4.620	4.554	0.529	26.450	26.449
'OH'	2	1.498	4.680	4.270	0.502	25.100	25.098
'RE'	2	1.524	4.480	3.608	0.476	23.800	23.796
'WA'	2	1.535	4.360	3.452	0.465	23.250	23.246
'GH'	2	1.561	4.520	4.290	0.439	21.950	21.949

MO = Momtaz FA = Fandoghi KA = Kallehghoochi JA = Jabbary EB = Ebrahimi
SH = Shasti OH = O'hadi RE = Rezaia WA = Wahedi GH = Gholam Rezaia

It is clear from the susceptibility index results (Table 6), that the varieties 'FA' and 'MO' with the susceptibility index values of 84.750 and 77.578 were the most susceptible foods while the varieties 'RE' and 'WA' with the index value of 41.119 and 45.887, were the least susceptible foods.

The result of this study reveal that dry fruits like cashewnut, pista, walnut, almond, hazelnut and mulberry are preferred foods of *Plodia interpunctella* (Hubner) and therefore special care should be taken to save these commodities from the attack of this pest. The damage to fig and raisin is not much and therefore, no special care is required for protection of these two fruits. The remaining three fruits namely apricot, coconut and chilgoza are not attacked by the pest in nature. Some larval feeding is witnessed on apricot and

TABLE 5
RELATIVE SUITABILITY OF TEN VARIETIES OF PISTA TO THE ATTACK BY *PLODIA INTERPUNCTELLA* (H.)

(based on three replications of 10 eggs each)

Food	Progeny Y	(Average) Development period (T_{50} days)	Index of suitability $\text{Log}_e Y/T_{50}$
'FA'	26	22.50	2.661
'O'H'	28	25.64	2.514
'GH'	26	24.23	2.471
'KA'	27	25.48	2. 440
'MO'	25	24.48	2.351
'JA'	26	25.65	2.334
'SH'	25	25.12	2.291
'EB'	22	23.77	2.131
'WA'	23	26.83	1.974
'RE'	20	26.65	1.728

$\text{Log}_e = 2.303$ (constant)
T_{50} = Time taken by 50% of the adults to emerge.

TABLE 6
RELATIVE SUSCEPTIBILITY OF TEN VARIETIES OF PISTA TO THE ATTACK BY *PLODIA INTERPUNCTELLA* (H.)

Food	Suitability index value (a)	Corrected mean % age of weight loss (b)	Susceptibility index value (axb)
'FA'	2.661	31.849	84. 750
'MO'	2 .351	32.998	77. 578
'KA'	2.440	29.699	72.465
'JA'	2.334	28.449	66. 400
'O'H'	2.514	25.098	63. 096
'SH'	2.291	26.449	60.594
'EB'	2.131	28.348	60. 409
'GH'	2.471	21.949	54. 235
'WA'	1.974	23.246	45. 887
'RE'	1.728	23.796	41.119

coconut under experimental conditions, whereas no feeding takes place in case of chilgoza.

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FRESHWATER CLADOCERA (CRUSTACEA : BRANCHIOPODA) OF THE ANDAMAN AND NICOBAR ISLANDS[1]

K. Venkataraman[2]

(*With one text-figure*)

Key words: Cladocera, 38 species, Andaman and Nicobar Islands

During 1990-92, 221 Cladocera samples were collected from 106 freshwater habitats throughout the Andaman and Nicobar Islands. A total of 38 species belonging to 21 genera of five families were identified, of which 24 were chydorids and 14 nonchydorids. The seven regions, viz. north, middle, south and little Andaman, Carnicobar, Nancowry group and Great Nicobar, were divided into two groups for the present study. All the seven stations were compared by the Sorensen index of similarity, and Koch index of biotal dispersity. The indices are generally high, reflecting the small number of species involved and their wide distribution, but two groups of stations are easily discernible. The indices for the Nicobar group of islands are somewhat lower, being influenced by the erratic occurrence of eurytopic species such as *Moina micrura*, *Ceriodaphnia cornuta* and *Macrothrix spinosa*, but they are clearly interrelated.

Introduction

The Andaman and Nicobars consist of over 550 islands, including several archipelagoes with a land area of 8,293 sq km. Being oceanic islands, they have hilly terrain and virgin forests, free flowing streams and cavities where water logging takes place throughout the monsoon. Irrigation reservoirs or lakes are absent, except for a few very small dams used mainly for drinking water (Danikari dam and Dilthaman tank, Port Blair). A few perennial water bodies, and many temporary cavities and rice fields are the main wetlands, where this study was conducted.

The Cladocera are dominant micro-crustaceans in the freshwater habitats of the Andaman and Nicobar islands, but they are not known taxonomically and ecologically as compared to those in the surrounding regions, such as the Indian mainland (Venkataraman, 1983; 1992a; Michael and Sharma, 1988; Venkataraman and Das, 1993), Sri Lanka (Rajapaksha and Fernando, 1987), Malaysia (Idris, 1983) and the Philippines (Mamaril, 1977). Except for Venkataraman (1991, 1992b, c), no worker has studied the freshwater bodies of Andaman and Nicobar Islands. Hence, this study on the occurrence of Cladocera was undertaken in the freshwater habitats of Andaman and Nicobar Islands.

Material and Methods

During 1990-92, 221 samples of Cladocera were collected from 106 freshwater habitats throughout the North (NA), Middle (MA) and South Andaman (SA), (Diglipur, Mayabunder, Rangat, Kadamthala, Port Blair, Havelock, Ross Islands and Little Andaman), Carnicobar (CN), Nancowry Group (NG) and Great Nicobar (GN) of Nicobar Islands (Fig. 1). Samples were collected from ponds, marshes, reservoirs, rice fields, dams, streams and rainwater pools, using a plankton net of 45 cm diameter, with circular mouth. The samples were usually collected in shallow water, among vegetation and in clear water. The net was dragged close to the bottom; excessive stirring of the mud was avoided. This technique gave a qualitative sample of shallow

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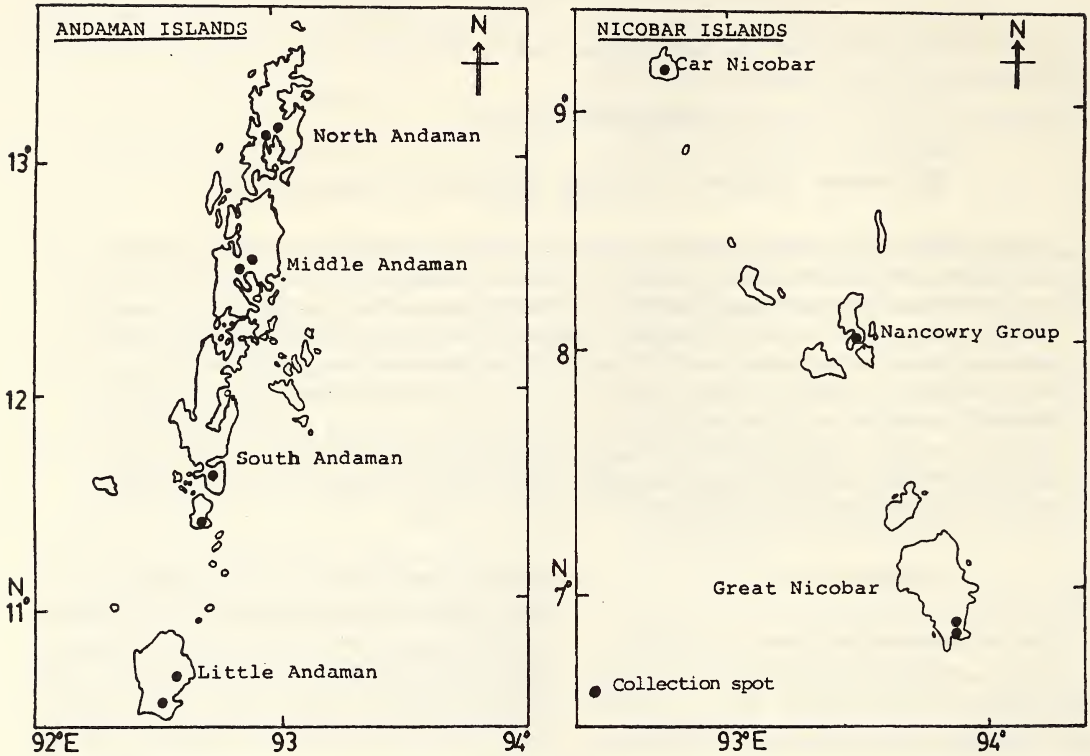

Fig. 1: Map of Andaman and Nicobar Islands showing the collection spots

water invertebrates living on the substratum, among vegetation and in the water column as in rice fields or marshes. The normal annual rainfall was 3,180 mm, mean max. temp. 29.98 °C and the mean min. temp. 23.13 °C. The mean relative humidity was 79%.

Descriptions of Some Rare Species

Brief descriptions of five rare species reported in the present study are given below. All the other 33 species recorded in this study have been described by Michael and Sharma (1988) from the Indian mainland, Malaysia (Idris, 1983) and Sri Lanka (Rajapaksha and Fernando, 1987).

Family Sididae

Diaphanosoma volzi Stingelin 1905

Material examined: 5 females from Bomila creek marsh, Little Andaman.

Female: Body size 0.73 mm. Head rounded and small, eye relatively large. Valves straight on ventral margin, duplicature forming a wide angle, posteroventral corner rounded, without denticles except for a long spine on the posterior margin. Postabdomen with three long and sharply pointed basal spines.

Remarks: Very rare. The material agrees with the description often mentioned under the name *D. aspinosum* by Chiang (1956) from China, and by Idris (1983) from Malaysia.

Family Macrothricidae

Guernella raphalis Richard 1892

Material examined: 3 females from Hut Bay nalla, Little Andaman, several females from roadside ponds in Wandoor, Port Blair.

Female: Body size 0.41 mm. Carapace

slightly oval. Head rounded anteriorly and concave ventrally; eye large, ocellus at the apex of rostrum. Antennule short and broad with lateral setae. Valves with polygonal reticulations, broadly rounded distally, ventral margin rounded and serrated. Claw short without basal spine.

Macrothrix laticornis (Jurine 1820)

Material examined: 6 females from Kadamthala fish pond (NA).

Female: Body size 0.48 mm. Head rounded; rostrum small with two antennules implanted with a bunch of subapical long spines and four rows of dorsal spines. Ventral margin with movable spines. Postabdomen thick and swollen, with numerous fine spines.

Family Chydoridae

Pleuroxus denticulatus Birge 1879

Material examined: 5 females from Yatrik pond, 7 females from Schoolline pond, 22 females from Coast Guard pond.

Female: Body size 0.42 mm. Shape broadly oval, with striated carapace. Posteroventral corner with 2-4 denticles. Rostrum long and pointed. Ocellus situated closer to the eye than to apex of rostrum. Postabdomen with 14-16 denticles with two basal spines on the claw.

Alona* cf. *dentifera (Sars 1901)

Material examined: 9 females from Murugan temple pond, 6 females from Schoolline pond, Port Blair (SA).

Female: Body size 0.45 mm. Valves with longitudinal lines. Posteroventral corner rounded, with three denticles. Ocellus slightly smaller than eye, situated half-way between eye and tip of rostrum. Labrum rounded anteriorly, slightly pointed ventrally. Postabdomen with prominent preanal and postanal corner, with 11 groups of denticles. Claw long, with a long basal spine.

Remarks: Rare. New record to India. Idris (1983) shifted this species from the genus *Alonella* to *Alona*. More studies are required to confirm the identity of this species.

Results and Discussion

A total of 38 species belonging to 21 genera of 5 families were identified in the 221 samples collected from different habitats during 1989-1991, of which 24 were chydorids and 14 nonchydorids. Of all the samples, only 10 contained no cladocerans. There were great differences between the islands in the number of cladocerans collected (Table 1).

As in the Northeast (Venkataraman, 1994, 1995), as well as Tamil Nadu and Rajasthan (Venkataraman, 1983, 1992a), cladocerans of the Andaman and Nicobar Islands are a mixture of tropical and temperate species (Table 2). *Ceriodaphnia cornuta*, *Moina micrura* and *Diaphanosoma excisum* are considered to be typically tropical species widely distributed from the northernmost tip Diglipur, to the other end, Great Nicobar. *Diaphanosoma volzi*, *Macrothrix laticornis*, *Pleuroxus denticulatus*, *Chydorus pubescens*, *Alona* cf. *dentifera* and *Leydigia acanthocercoides*, which are considered to be temperate in origin, occur in Andaman and Nicobar Is. (Table 1).

Cladoceran hatching and growth rate is controlled by temperature, which ranged from 29-32 °C (Table 3) in the study. The pH range of these wetlands was narrow, 7.25 to 8.90. Previous workers Bayly (1963), Moitra and Bhattacharya (1965) and Chengalath (1982) showed that Cladocera and other freshwater zooplankton populations vary inversely with pH. However, the present study does not show any such significant variation.

The study areas receive monsoon rain from March through October. This continuous rainfall dilutes the ionic strength and nutrient levels of the water, which in turn may affect the proliferation of cladoceran population. It also increases the oxygen content of the water along

TABLE 1

OCCURRENCE OF CLADOCERA (IN NUMBER OF SAMPLES) IN DIFFERENT REGIONS OF ANDAMAN AND NICOBAR ISLANDS (TOTAL NUMBER OF SAMPLES COLLECTED IS GIVEN IN PARENTHESIS)

		Andaman				Nicobar		
Sl. No.	Cladocera species	North Andaman (20)	Middle Andaman (30)	South Andaman (96)	Little Andaman (44)	Carnicobar (10)	Nancowry Group (6)	Great Nicobar (15)
Family Sididae								
1.	*Pseudosida bidentata*	2	-	-	-	-	-	-
2.	*Latonopsis australis*	-	-	3	1	-	-	1
3.	*Diaphanosoma sarsi*	3	4	10	3	-	-	2
4.	*Diaphanosoma excisum*	1	3	28	-	-	-	-
5.	*Diaphanosoma volzi*	-	-	-	1	-	-	-
Family Daphniidae								
6.	*Ceriodaphnia cornuta*	5	7	18	6	3	1	3
7.	*Scapholeberis kingi*	-	1	7	-	-	-	-
Family Moinidae								
8.	*Moina micrura*	6	13	19	5	-	-	1
9.	*Moinodaphnia macleayi*	-	-	5	-	-	-	-
Family Macrothricidae								
10.	*Macrothrix spinosa*	1	1	9	3	-	1	3
11.	*Macrothrix laticornis*	-	1	-	-	-	-	-
12.	*Echinisca triserialis*	-	-	18	2	-	1	-
13.	*Ilyocryptus spinifer*	-	1	7	3	-	-	-
14.	*Guernella raphalis*	-	-	2	1	-	-	-
Family Chydoridae								
Subfamily Chydorinae								
15.	*Pleuroxus similis*	-	-	-	4	-	-	-
16.	*Pleuroxus denticulatus*	-	-	6	-	-	-	-
17.	*Chydorus ventricosus*	-	1	19	3	-	-	-
18.	*Chydorus reticulatus*	7	13	22	5	-	-	-
19.	*Chydorus eurynotus*	5	6	9	2	-	1	1
20.	*Chydorus parvus*	-	1	6	-	-	-	-
21.	*Chydorus barroisi*	-	-	17	-	-	-	-
22.	*Chydorus pubescens*	-	1	-	-	-	-	-
23.	*Dadaya macrops*	1	2	8	2	-	-	1
24.	*Dunhevedia crassa*	-	2	12	3	-	-	1
25.	*Dunhevedia serrata*	-	1	7	-	-	-	-
Subfamily Aloninae								
26.	*Alona monacantha*	1	-	8	-	-	-	-
27.	*Alona* cf. *dentifera*	-	-	3	-	-	-	-
28.	*Alona pulchella*	-	6	12	4	-	-	-
29.	*Alona guttata*	-	2	-	-	-	-	-
30.	*Alona davidi*	-	-	18	5	-	-	-
31.	*Alona karua*	2	5	12	3	-	-	-
32.	*Alona verrucosa*	-	-	6	-	-	-	-
33.	*Oxyurella sinhalensis*	-	-	10	-	-	-	-
34.	*Kurzia longirostris*	1	-	7	2	-	-	1
35.	*Euryalona orientalis*	-	-	4	-	-	-	-
36.	*Notalona globulosa*	2	-	7	-	-	-	-
37.	*Leydigia acanthocercoides*	1	1	3	-	-	-	1
38.	*Leydigia australis*	-	-	4	-	-	-	-
Total number of species		14	20	32	19	1	4	10

TABLE 2
OCCURRENCE OF SPECIES OF CLADOCERA IN DIFFERENT STATES OF INDIA

Sl. No.	Name of the family	Tamil Nadu	Rajasthan	West Bengal	Tripura	Andaman and Nicobar	India (total)
		Number of species of Cladocera					
1.	Sididae	5	5	5	5	5	6
2.	Daphniidae	12	12	9	7	2	17
3.	Moinidae	2	4	3	2	2	5
4.	Bosminidae	-	1	2	2	-	2
5.	Macrothricidae	4	8	6	4	5	8
6.	Chydoridae	23	24	32	29	24	47
	Total	46	54	57	49	38	85

with the nutrient level in the wetlands of Andaman (Table 4).

The seven regions viz. north, middle, south and little Andaman, Carnicobar, Nancowry group and Great Nicobar have been divided into two groups for the purpose of the present study. The four northern regions known as the Andaman group have fourteen or more species

TABLE 3
PHYSICOCHEMICAL PARAMETERS OF THE FRESHWATER PONDS AND LAKES STUDIED IN ANDAMAN AND NICOBAR ISLANDS.

Sl. No.	Name of the pond	Date	pH	Surface water Temp. °C	Conductivity mmhos	O_2 mg/l	Transparency cm
1.	Mayabundar (NA)	23.01.91	5.5	-	8.70	-	-
2.	Schoolline pond (SA)	28.04.90	-	-	3.80	-	-
3.	Dhobi pond (SA)	21.05.90	8.53	32.3	1.30	4.10	30
4.	Yatrik pond I (SA)	21.05.90	7.95	33.0	2.00	8.10	75
5.	Bay Island Hotel Pond (SA)	25.05.90	8.70	31.2	4.00	10.42	50
6.	Murugankoil pond (SA)	02.06.90	7.09	29.9	2.40	6.05	
7.	Murugankoil pond (SA)	02.07.90	7.17	30.8	2.00	-	-
8.	Dhobi pond (SA)	02.07.90	7.59	30.2	7.30	-	-
9.	Murugankoil pond (SA)	09.07.90	7.78	31.2	6.90	-	
10.	Murugankoil pond (SA)	17.7.90	7.29	29.5	7.50	5.70	-
11.	Murugankoil pond (SA)	18.07.90	7.04	30.4	8.00	5.90	-
12.	Murugankoil pond (SA)	19.07.90	7.26	30.2	3.00	5.20	-
13.	Yatrik pond (SA)	27.7.90	8.94	31.5	1.90	6.00	-
14.	Dhobi pond (SA)	18.07.90	8.50	31.5	6.60	10.30	-
15.	Dhobi pond (SA)	19.07.90	7.34	29.7	5.70	5.30	-
16.	Coastguard Pond (SA)	19.07.90	8.36	30.1	2.00	6.20	-
17.	Schoolline pond (SA)	08.08.90	7.35	31.4	0.11	7.78	-
18.	Yatrik pond (SA)	08.10.90	7.26	30.8	2.00	8.00	-
19.	Havelock pond I (SA)	23.01.91	5.50	-	8.70	-	-

TABLE 4
PHYSICOCHEMICAL PARAMETERS OF THE SURFACE RUN OFF WATER BEFORE AND AFTER RAIN IN THE CANALS OF PORT BLAIR DURING MAY 1990

Sl. No.	Canals of Port Blair	Conductivity in mmhos		pH		O_2 mg/l		Total solid mg/l		Dissolved solids mg/l	
		Before Rain	After Rain	Before Rain	After Rain	Before Rain	After Rain	Before Rain	After Rain	Before Rain	After Rain
1.	Murugan temple	4.6	6.9	7.40	7.02	6.54	6.43	120	3800	500	1200
2.	Shadipur canal	2.1	4.1	7.61	7.48	6.34	6.63	340	2000	500	1400
3.	Phoenix Bay canal	8.0	11.3	7.51	7.49	4.27	4.73	3300	5700	1000	2000
4.	Anarkali canal	9.3	8.4	7.88	7.64	6.19	6.53	770	21800	700	2200
5.	Megapod Nest canal	3.3	3.4	7.68	7.70	5.88	6.36	1250	1300	200	900
	Mean	6.0	8.37	7.64	7.49	5.97	6.25	683	6017	533	3000
	Deviation	2.57	4.76	0.17	0.25	0.86	0.76	577	7910	287	3609

of Cladocera each, while the southern three regions known as the Nicobar group have only one to ten species.

The seven stations have been compared by the Sorensen index of similarity. This was calculated for each combination of stations according to the following equation (Sorensen, 1948): S=2c/a+b x 100, where 'c' is the number of species common to both associations, 'a' the number of species in one association and 'b' the number of species in the other association. The results for 21 pairs of stations are given in Table 5. The indices are generally high, reflecting the small number of species involved and their wide distribution, but the two groups of stations are easily discernible. Andaman group (4 stations) have highly interrelated indices. Those for the Nicobar group are lower, being influenced by the erratic occurrence of eurytopic species such as *Moina micrura*, *Ceriodaphnia cornuta* and *Macrothrix spinosa*, but they are clearly interrelated. Andaman Islands closely resemble each other, the Great Nicobar closely resembles Nancowry group, whereas Carnicobar is unique (Table 5).

Koch (1957) has devised an index of biotal dispersity (IBD) which can be used to assess the wide dispersity of species between islands. IBD =T-S/S(n-1) x 100, where 'T' is the arithmetical sum of species living in each 'n' compared associations and 'S' is the total list of species in 'n' compared associations. If each station had a completely different set of species, 'S' should equal 'T' and the IBD would be 0%. If each station had an identical set of species, 'T' would equal n x S and the IBD would be 100%.

When the Koch index for all seven stations was calculated, the resulting IBD was 27, but when separate indices were calculated for the Andaman and Nicobar groups, there was an increase in the IBD for the former (40) and a decrease for the latter (18). The large increase in IBD when the Andaman group were considered separately indicates that these

TABLE 5
SORENSEN INDICES FOR CLADOCERA FROM SEVEN DIFFERENT ISLAND GROUPS OF ANDAMAN AND NICOBAR

	1	2	3	4	5	6	7
1	-	53	59	53	13	33	67
2	53	-	64	60	10	25	33
3	59	64	-	68	7	24	45
4	53	60	68	-	10	58	60
5	13	10	7	10	-	40	18
6	33	25	24	58	40	-	43
7	67	33	45	60	18	43	-

1 - North Andaman; 2- Middle Andaman; 3 - South Andaman; 4 - Little Andaman; 5 - Carnicobar; 6 - Nancowry Group; 7 - Great Nicobar.

regions resemble each other in Cladocera fauna much more than they resemble the Nicobar group. This agrees well with the Sorensen indices.

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LONGICORN BEETLES (CERAMBYCINAE, PRIONINAE : CERAMBYCIDAE) OF BUXA TIGER RESERVE, JALPAIGURI, WEST BENGAL[1]

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(*With twelve text-figures*)

Key words: Taxonomy, Cerambycidae, Cerambycinae, Prioninae, Buxa Tiger Reserve, West Bengal

The paper deals with the taxonomy of 12 species of Cerambycidae (Cerambycinae and Prioninae) of Buxa Tiger Reserve. Of these, 7 species *Ceresium leucosticticum* White, *C. rufum* Lameere, *Hoplocerambyx spinicornis* Newman, *Macrotoma* (*Zooblax*) *spinosa* (Fabricius), *Tetraommatus filiformis* Perroud, *Thranius simplex* Gahan and *Xoanodera regularis* Gahan, are new records from the state of West Bengal. The species have been described and suitably illustrated. Identification keys are provided wherever necessary.

INTRODUCTION

Family Cerambycidae refers to the longhorn beetles. These coleopterans are wood borers in their larval stages, for which they are extremely important in any forest ecosystem. Because of their great economic importance, these beetles have received serious attention. Up to 1200 species of cerambycids are reported from the Indian region, largely dominated by the Lamiinae (Beeson, 1961). The systematics, biology and ecology of these beetles have been worked out. Khan and Maiti (1983) while dealing with the biotaxonomy, biology and ecology of some of these borers have reviewed the works of others, e.g. Stebbing, Beeson, Beeson and Bhatia, Husain and Khan, Bhasin and Roonwal, Bhasin *et al.*, and Dutt. Basak and Biswas (1993) have remarked "our present state of knowledge of longicorn beetles of the state of Orissa is very incomplete and fragmentary", and "no comprehensive work on the longicorn beetles from Orissa is available". They, however, listed 32 species belonging to 27 genera under 3 subfamilies as the cerambycid fauna of Orissa. Though they indicated the distribution of some of these species in West Bengal, recent State Fauna Series 3: Fauna of West Bengal Pt 6A, 6B (Insecta : Coleoptera), 1995-96 Z.S.I. did not include Cerambycidae.

Our survey of Buxa forest, presently known as Buxa Tiger Reserve (Jalpaiguri, West Bengal) during 1994-97 revealed the existence of 12 species of longhorn beetles (Cerambycinae; Prioninae) belonging to 11 genera. Raychaudhuri (1996) had reported 10 species belonging to 10 genera of the same subfamilies from the forest. Besides, we have several species of lamiids in our collection. We now present the taxonomic details of the beetles belonging to the subfamilies Cerambycinae and Prioninae. Incidentally, Basak and Biswas (1993) have not presented any taxonomic key or detailed description of the 32 listed species. Such a taxonomic treatise is necessary for India, as several decades have elapsed since the publication of Gahan (1906). This paper details the morphology of each species, together with keys, even of the higher categories. All the species have been illustrated. *Ceresium leucosticticum* White, *C. rufum* Lameere, *Hoplocerambyx spinicornis* Newman, *Macrotoma spinosa* (Fabricius), *Tetraommatus filiformis* Perroud, *Thranius simplex* Gahan and *Xoanodera regularis* Gahan appear to be new records from the state of West Bengal.

All the reported species are at present in the collection of Entomology Laboratory, Department of Zoology, University of Calcutta.

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Material and Methods

Insect samples have been collected and preserved for further study following the recommendations of Zoological Survey of India, Calcutta (Ghosh and Sengupta, 1982).

Abbreviations used:

BG	-	Bhutanghat
B.T.R.	-	Buxa Tiger Reserve
DM	-	Damanpur
EL	-	Length of elytra
EW	-	Humeral width of elytra
FA	-	Apical width of frons
FL	-	Length of frons
HW	-	Maximum width of head
JY	-	Jayanti
LT	-	Light trap
NL	-	Newland
NM	-	Nimati
PA	-	Apical width of pronotum
PB	-	Basal width of pronotum
PK	-	Phaskhawa
PL	-	Length of pronotum
PN	-	Panbari
PW	-	Maximum width of pronotum
RB	-	Rajabhatkhawa
RM	-	Raimatang
SB	-	South Bholka
SR	-	South Raydak
TG	-	Tashigaon

Taxonomy

Key to Subfamilies, Tribes and Genera

1. Prothorax marginate at sides, sometimes entire, more frequently dentate or spinose; fore coxae strongly transverse; antennae usually inserted close to mandibular base; mesonotum without stridulatory area (except in *Philus*); vein Cu2 usually present; vein A1 with a large subelliptical cell .... Prioninae

A. Episterna of metathorax with posteriorly converging sides, narrowly truncate or obtusely pointed at apex; intercoxal process of prosternum arched; lateral margins of prothorax unarmed or with 1-3 spines or teeth; antennal joints spinose; 1st antennal joint short .... Megopidini, *Megopis* Serville

— Episterna of metathorax parallel-sided for greater part of their length, broadly truncate behind; intercoxal process of prosternum flat and horizontal; lateral margins of prothorax crenulate, denticulate or spinulose; antennal joints not spinose, if at all with short spines; 1st antennal joint long or moderately long .... Macrotomini, *Macrotoma* Serville

— Prothorax emarginate at sides; fore coxae rarely strongly transverse; antennae inserted at some distance from base of mandibles; mesonotum generally with stridulatory area; veins Cu2 and branch of Cu1 usually absent; vein A1 mostly without any cell .... Cerambycinae

A. Intercoxal process of prosternum not or weakly dilated at apex .... a

a. Ligula corneous; antennae never ciliated but may have long pubescence; vein Cu2 absent .... Oemini

a1. Head flat between antennae; 1st coxae contiguous; antennae never spinose or dentate .... *Tetraommatus* Perroud

— Head raised forming a ridge, broadly concave between antennae; 1st coxae separate; antennae dentate .... *Xystrocera* Serville

— Ligula membranous; antennae ciliated; either vein Cu2 or posterior branch of Cu1 absent .. .. Hesperophanini, *Stromatium* Serville

— Intercoxal process of prosternum distinctly dilated at apex .... B

B. Acetabula of fore coxae closed or nearly closed posteriorly, rarely angulated on outer side i

i. Metasternum with scent-pores; acetabula of middle coxae extended to epimera .... Callichromini, *Anubis* Thomson

— Metasternum without scent-pores; acetabula of middle coxae open to epimera .... Cerambycini

a1. Pronotum transversely irregularly wrinkled with broken ridges; elytra with a spine at sutural apex; 1st joint of hind tarsus nearly as long as the next two united .... *Hoplocerambyx* Thomson

— Pronotum without ridge, instead either transversely grooved near base and apex or with variable number of sharp, straight, longitudinal costae; elytra without spine at sutural apex; 1st joint of hind tarsus shorter than next two united .... *Xoanodera* Pascoe

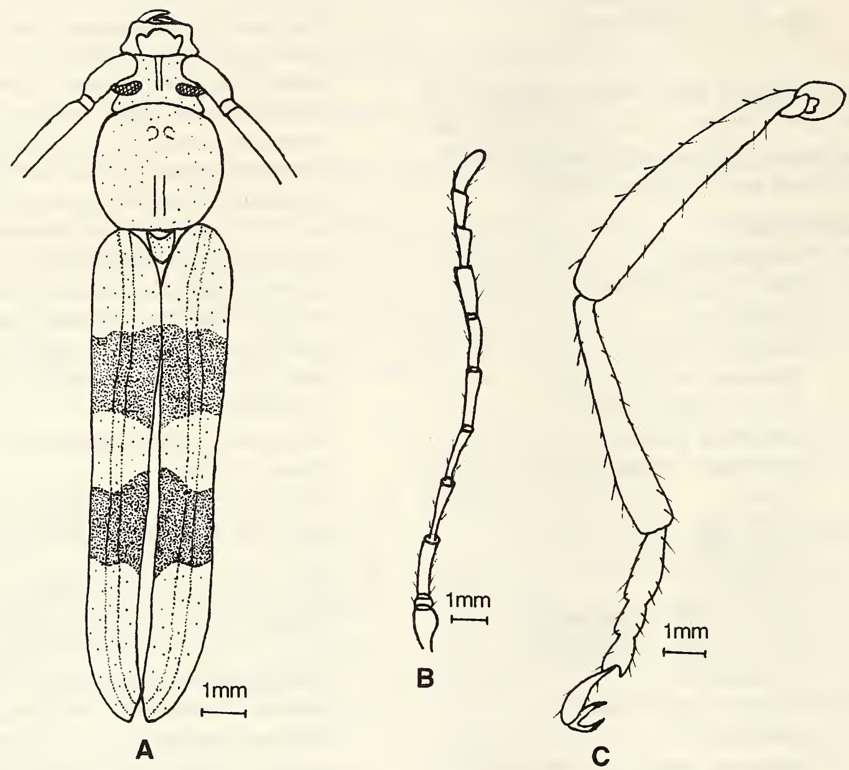

Fig. 1: *Anubis inermis* (White): A. Whole body, B. Antenna, C. Hind leg

— Acetabula of fore coxae open posteriorly, angulated on outer side ii

ii Eyes coarsely faceted .... Callidiopsini, *Ceresium* Newman

— Eyes finely faceted iii

iii. Elytra dehiscent posteriorly, acuminate at apex; front coxae prominent, contiguous; prothorax parallel-sided .... Thranini, *Thranius* Pascoe

— Elytra neither dehiscent nor acuminate at apex; front coxae not prominent, globular and not contiguous; prothorax with sides weakly to distinctly rounded ....Clytini, *Xylotrechus* Chevrolat

Subfamily 1: Cerambycinae

Tribe: Callichromini

Genus: *Anubis* Thomson

Anubis, Thomson 1864, Syst. Ceramb. : 177.

Type-species: *Anubis clavicornis* Fabricius

Anubis inermis (White)
(Fig. 1)

Polyzonus inermis White 1853,
Cat. Coleopt. B.M., Longic.: 171.

Male: Head, antennal segment I, pronotum, scutellum, elytra at base and apex chalybeate blue, pronotal disc and elytra violaceous, elytra with a pair of yellow transverse bands, one just above the middle and the other just below the middle, antennae and legs blue-black; body beneath clothed with silvery grey pubescence.

Head at base narrower than pronotum, much narrowed beyond eyes, densely and coarsely punctate; vertex flat; frons midlongitudinally sulcate between the antennae; clypeus broad, flat, transverse; HW/PA 1.11; FA/FL 0.46;

mandibles robust, weakly curved, strongly dentate; genae long, midlongitudinally faintly raised, sloped on either side; eyes deeply emarginate, extending beyond antennal support. Antennae 11-segmented, a little longer than body, gradually swollen apically, segment III longest, last segment longer than the penultimate, obtuse at apex. Pronotum ovate cylindrical, longer than broad, lateral margin rounded, basally nearly straight, apically a little constricted, densely and coarsely punctate; PL/PA 1.52, PL/PW 1.0, PB/PA 1.0, PB/EW 3.09. Scutellum small, triangular and obtuse, finely and rather densely punctate. Elytra long, parallel-sided, rounded at apex, finely and very densely punctate, those near base large and distinct, a pair of costae evidently running from the middle of the base almost to apex; EL/EW 18.18; metasternum midlongitudinally sulcate and free of pubescence; abdominal venter at sides with more dense pubescence. Legs moderately long, femora pedunculate, gradually subclavate, densely punctate, joint 1 of hind tarsi longer than 2+3.

Body length: 13-17 mm.

Material examined: 1 male, PK, B.T.R., Jalpaiguri, West Bengal, 9.v.1994.

Distribution: INDIA: Sikkim, West Bengal; Laos; Malaysia; Myanmar; Pakistan; South China; Thailand (Gahan, 1906; Gressitt and Rondon, 1970).

Tribe: Callidiopsini

Genus: *Ceresium* Newman

Ceresium Newman, 1842. Entomologist, i: 322.

Type-species: *Ceresium raripilum* Newman

KEY TO SPECIES

1. Elytra with yellow-white pubescence, 1st pair oblique, near scutellar apex, 2nd round, transverse, marginal, 3rd oblique, close to suture and 4th comma-shaped, transverse, marginal near apex; head without any pubescence near base; body brown-black; antennae twice as long as body .... *leucosticticum* White

— Elytra without any such pubescence; head with yellow-white pubescence between eyes near base; body reddish brown; antennae a little shorter than body .... *rufum* Lameere

Ceresium leucosticticum White

(Fig. 2)

Ceresium leucosticticum White, 1855, Cat. Col. B.M. Longic. 2: 245.

Male: Brown black, with elytra centro-medially reddish, pronotum laterally with 2 pairs of yellow white pubescence, 1st pair near apex, other pair almost basal, scutellum with similar pubescence, elytra also with similar pubescence arranged thus: 1st pair near scutellar apex, rather oblique, broad distally, 2nd pair at basal 1/3, transverse, circular, placed marginally, 3rd almost at midlength, near the suture, oblique, directed towards apex, 4th near the turning of elytra, transverse, marginal, comma-shaped, directed towards apex, eyes at inner margin with semilunar band of similar pubescence; antennae reddish brown, with faint pubescence; legs reddish brown with femora apically darker; body ventrally red brown to dark brown, with yellow white pubescence laterally.

Head a little narrower than pronotum, densely punctate, concave between antennae; frons midlongitudinally sulcate; vertex sloped towards eyes, anteriorly truncate; clypeus transverse, band-like; HW/PA 1.16; FA/FL 0.9; eyes emarginate. Antennae 11-segmented, slender, twice as long as body, 1st joint closely punctate, little longer than 3rd, nearly equal to 4th, 5th and following segments longer, 10th twice as long as 11th. Pronotum elongately rectangular, longer than wide, marginally rounded, medially broad, densely and coarsely punctate, clothed with short hairs; PL/PA 1.15, PL/PW 1.15, PB/PA 0.93, PB/EW 1.40. Scutellum small, obtuse. Elytra parallel-sided, narrowed just before the truncate apex, densely

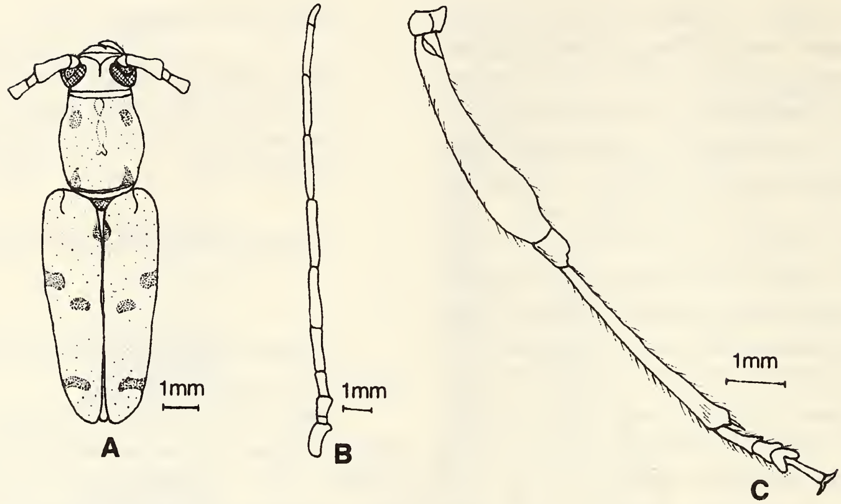

Fig. 2: *Ceresium leucosticticum* White: A. Whole body, B. Antenna, C. Hind leg

punctate, clothed with short hairs; EL/EW 5.35; prosternum truncate, punctate; metasternum plate-like, midlongitudinally with a black streak. Legs moderately long, femora basally pedunculate, apically clavate, hind legs extending much beyond the abdomen.

Body length: 12 mm.

Material examined: 2 males, RB(LT), B.T.R., Jalpaiguri, West Bengal, 22.v.1995, 25.v.1995.

Distribution: INDIA : Assam (Gahan, 1906), West Bengal; Indonesia; Laos; Myanmar; South China; Thailand (Gahan, 1906; Gressitt and Rondon, 1970).

Ceresium rufum Lameere
(Fig. 3)

Ceresium rufum Lameere, 1890, Ann. Soc. Ent. Belge, 34, C.R. : cc 11.

Male: Reddish brown, densely pubescent, head with 2 white semilunar bands of pubescence, pronotum with such pubescence submarginally, anterior ones round, posterior ones rather elongate and longitudinal, extending a little on the basal margin, scutellum with similar pubescence, elytra without any such, antennae reddish brown, 9th joint onwards much darker, legs reddish brown, body ventrally red brown with white pubescence laterally.

Head narrower than pronotum, anteriorly narrowed, densely punctate; frons concave, midlongitudinally sulcate, anteriorly subquadrate; vertex sloped towards eyes, anteriorly truncate; clypeus transverse, band-like, truncate; HW/PA 1.12, FA/FL 0.69; eyes emarginate. Antennae 11-segmented, slender, a little shorter than body; 4th joint much shorter than any of the succeeding joints, hairy beneath. Pronotum elongately rectangular, longer than wide, marginally rounded, broad medially; pronotal disc with dense, coarse, transverse rugosities, clothed with short hairs; PL/PA 1.25, PL/PW 1.00, PB/PA 1.04, PB/EW 2.06. Scutellum small and obtuse. Elytra parallel-sided, narrowed just before the truncate apex, strongly punctate, those towards apex feeble and scanty, clothed with short, dense hairs; EL/EW 8.31; prosternum truncate, punctate; metasternum plate-like, midlongitudinally with a black streak. Legs moderately long, clothed with rather long pubescence, femora basally pedunculate, apically clavate, hind legs extending much beyond the abdomen.

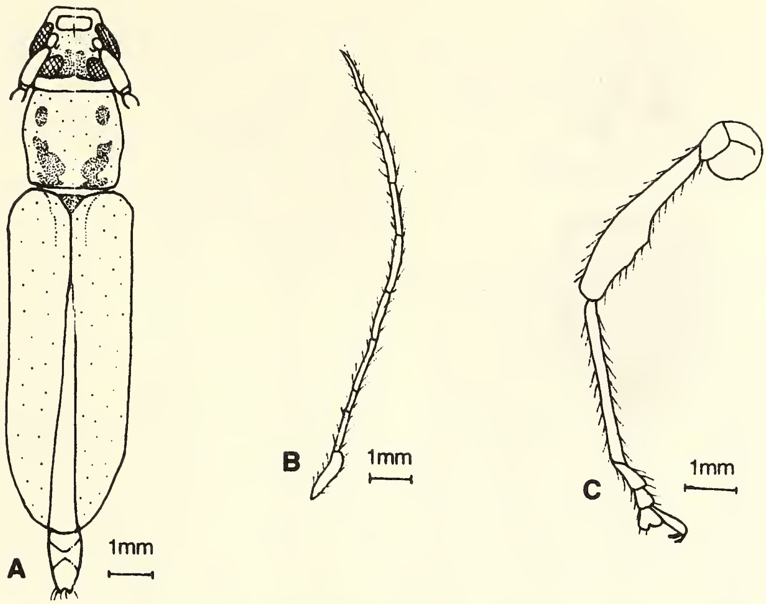

Fig. 3: *Ceresium rufum* Lameere: A. Whole body, B. Antenna, C. Hind leg

Body length: 13 mm.

Material examined: 1 male, SB(LT), B.T.R., Jalpaiguri, West Bengal, 21.v.1997.

Distribution: INDIA: Kunbur (Gahan, 1906), West Bengal; Myanmar (Beeson, 1961).

Tribe: Cerambycini
Genus: *Hoplocerambyx* Thomson
Hoplocerambyx Thomson, 1864, Syst. Ceramb.: 229.
Type-species: *Hammaticherus spinicornis* Newman

Hoplocerambyx spinicornis (Newman)
(Fig. 4)

Hammaticherus spinicornis Newman, 1842, Entomologist, 1: 245.

Male: Pitch brown, ventrally more reddish; head, pronotum, antennae, legs and underside with fine grey pubescence, elytra more densely covered with red-ochraceous silky pubescence, faintly banded light and dark.

Head strongly exserted, apically finely punctate, basally wrinkled, with the vertex deeply grooved medially, extending between the eyes, continuing as a shallow groove between antennal supports, carinate on either side; frons oblique with a fovea on each side; clypeus apically sinuate, basal submedian area bi-tuberculate, sloping towards the frontal fovea with a few long, grey hairs at the corners; genae long; slightly shorter than width of pronotum; HW/PA 1.22; FA/FL 0.50; mandibles longer than in female, straight at base; eyes deeply emarginate, not extending beyond the antennal supports; gula with 3 strong transverse ridges. Antennae 11-segmented, 1/5 to 1/3 longer than body, faintly pubescent, 1st to 7th segments sparsely but strongly punctate, 3rd segment onwards spinose, 8th segment onwards gradually shortened and almost weakly so on the last segment, flattened or slightly canaliculate above. Pronotum a little longer than broad, constricted in front, rounded at the sides between the anterior constriction and the base; the disc with a slightly raised oblong space in the middle, the rest of the surface with deep, irregular, transverse wrinkles, with the

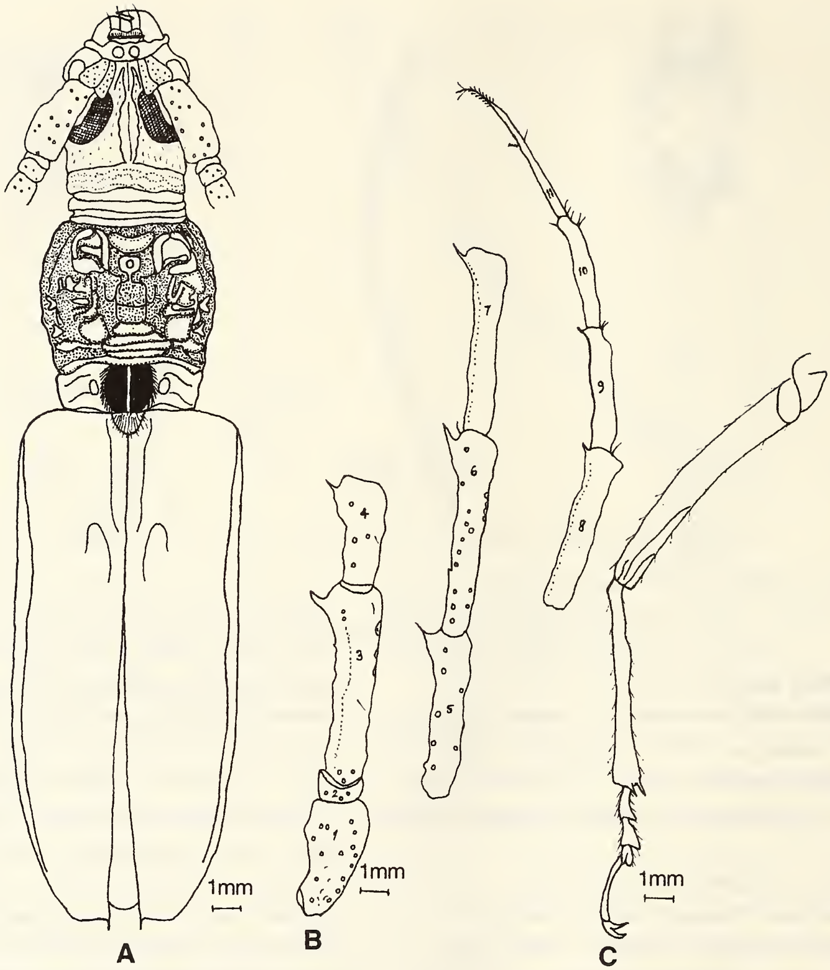

Fig. 4: *Hoplocerambyx spinicornis* Newman: A. Whole body, B. Antenna, C. Hind leg

ridges more or less broken and convolute towards the sides, at base with 2 transverse ridges continuing up to the margin; PL/PA 1.22, PL/PW 0.79, PB/PA 1.14, PB/EW 1.34. Scutellum pitch brown, small and broadly triangular, with grey pubescence. Elytra with a slight elevation close to the suture at about 1/4 of their length; each elytron convex, narrow posteriorly, obliquely truncate at apex, with a spine at suture and a feeble tooth at outer angle, the surface (where rubbed bare of pubescence) with 2 kinds of punctures, some minute and very dense, others larger and less numerous, suture just below the scutellum reflexed; EL/EW 5.39; prosternum very sparsely scattered with punctures, moderately pubescent, with hind margin of epipleural process moderately arcuate. Venters of meso- and metathoracic segments hardly punctate, clothed with silky grey pubescence, metasternum midlongitudinally sulcate, abdominal venter with fine silky pubescence. Legs moderately long and stout; femora slightly compressed, hind pair scarcely reaching the elytral apex, gradually swollen apically and widest at apical 3/5; hind tibia long and slender; hind tarsi 1 as long as 2+3; claw-bearing joint of

the tarsi long and paronychium nearly always distinctly visible between the claws.

Body length: 32-51 mm.

Material examined: 2 males, PN, B.T.R., 20.v.1995; 1 male, RB, B.T.R., 20.v.1995; 1 female, DM, B.T.R., 23.v.1995; 2 males, JY(LT), B.T.R., 24.v.1995, 25.v.1995; 1 male, RB(LT), 16.ix.1996; 1 male, SB, B.T.R., 20.v.1997; 1 male, NM, B.T.R., 21.v.1997. All from Jalpaiguri, W.Bengal

Distribution: INDIA: Assam, Uttar Pradesh (Gahan, 1906), Gujarat, Karnataka, Maharashtra, Rajasthan (Beeson, 1961), Bihar, Madhya Pradesh, Orissa (Basak and Biswas, 1993), West Bengal; Afghanistan; Indonesia; Laos; Malaysia; Myanmar; Nepal; The Philippines; Singapore; Sunda Island (Gahan, 1906; Gressitt and Rondon, 1970).

Genus: *Xoanodera* Pascoe

Xoanodera Pascoe, 1857, Ent. Soc. (2) iv : 92.

Type-species: *Xoanodera trigona* Pascoe

Xoanodera regularis Gahan

(Fig. 5)

Xoanodera regularis Gahan, 1890, A.M.N.H. (6) V : 52.

Male : Dark brown, head, pronotum and elytra (greater part) with dense yellowish-brown pubescence, elytra at base with a ring-like dark brown band encircling the scutellum and a lateral area from the shoulders extending a little beyond the middle dark brown, devoid of dense pubescence; the narrow border between submarginal carina and outer margin sparsely pubescent. Head and 1st antennal joint closely

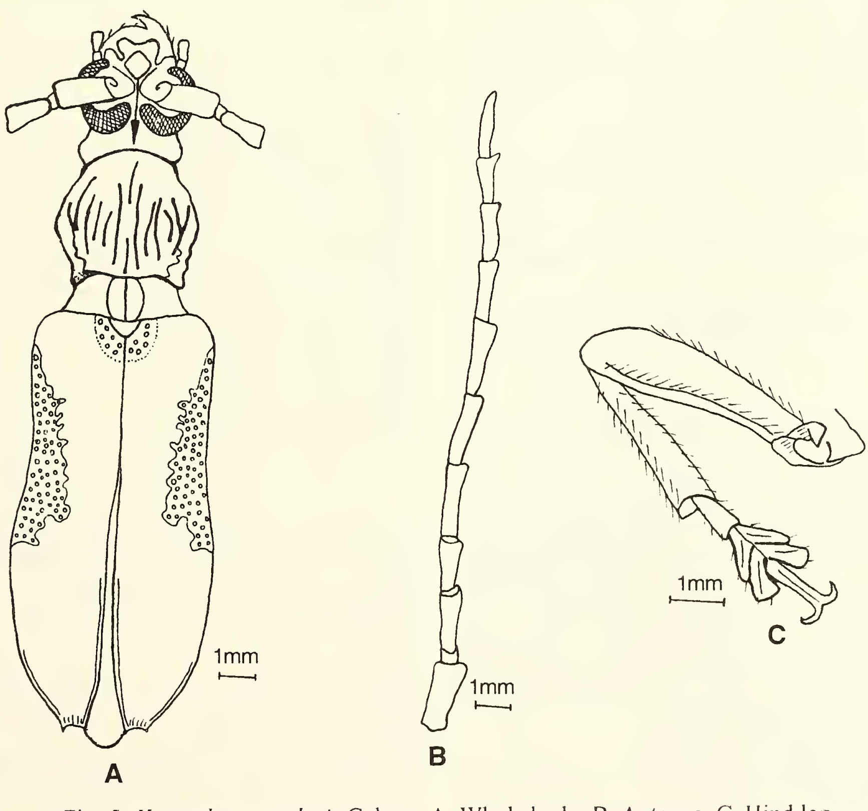

Fig: 5: *Xoanodera regularis* Gahan: A. Whole body, B. Antenna, C. Hind leg

rugulose-punctate. Antennae reddish brown, with a faint covering of grey pubescence. Pronotum strongly and irregularly ridged, scantily clothed with patches of tawny pubescence, laterally with a dense, yellowish brown pubescence. Thoracic and abdominal sternites rather densely covered with greyish white pubescence, legs less so.

Head shorter and narrower than pronotum, broadest across eyes, anteriorly sloped, medially raised, posteriorly weakly sloped to a little beyond the eyes, medially with a deep longitudinal sulcus, 2 such on either side of the median, or just behind the antennal socket; vertex densely punctate, and entirely covered by pubescence; frons medially lobed, enclosed by a deep circular sulcus, anterolaterally broadly produced, truncate; clypeus broadly rectangular; HW/PA 1.20; FA/FL 0.50; mandibles broad at base, curved, bluntly pointed at apex, with lateromedian depression, outer margin reflexed up to a little beyond the middle; eyes large, deeply emarginate, extending almost to the frontal sulcus, closely approximated above, with a narrow space in between. Antennae 11-segmented, a little shorter than body, densely covered by minute pubescence; 5th to 10th joints sharply edged in front and acutely angulated at apex, 11th shorter than 10th. Pronotum as long as broad, sides unevenly rounded, apex with 1 and base with 2 transverse grooves; PL/PA 1.44, PL/PW 0.90, PB/PA 1.17, PB/EW 1.66. Scutellum obtuse, with dense pubescence. Elytra parallel-sided, narrowed near apex, posterior submarginal carina with apex truncate and feebly bidentate; EL/EW 6.75; prosternum raised between coxae, sharply deflexed posteriorly, and dilated at the end to meet the epimera, acetabula of front coxae not angulated outwards. Legs moderately long, femora carinate on each side near their lower portions; 1st joint of hind tarsus shorter than the next 2 united.

Body length: 20-21 mm.

Material examined: 2 males, SR, Jalpaiguri, West Bengal, 5.iv.1993.

Distribution: INDIA: North India?, West Bengal; Laos; Myanmar (Gahan, 1906; Gressitt and Rondon, 1970).

Tribe: Clytini

Genus: *Xylotrechus* Chevrolat

Xylotrechus Chevrolat, 1860, Ann. Soc. Ent. Fr. : 456.

Type-species: *Xylotrechus sartorii* Chevrolat

Xylotrechus smei (Lap. et Gory)

(Fig.: 6)

Clytus smei Lap. et Gory, 1841, Hist. Nat. et Iconogr. des Ins. Coleopt. : 37.

Male: Black, head and most of pronotum with olive green and yellowish pubescence, such pubescence on elytra forming bands and spots; pronotal disc with 3 black spots, one centrally near base, the other two very near the middle, but a little marginal; elytral bands and spots are as follows: 1) elongately circular yellow band, with the outer margin rather narrow, a little discontinuous near the scutellar apex enclosing (2) a transverse marginal yellow broad band extending to the shoulder hump and narrowing towards the suture, (3) midposteriorly with a transverse yellow band at sutural margin, broad, narrowed towards the margin, (4) apical yellow band broad at apex and narrowed in front with the margin oblique; venter with bands or spots of whitish pubescence.

Head a little narrower than pronotum, anteriorly sloped; vertex flat with a median longitudinal carina bifurcating anteriorly; frons with 4 carinae, outer ones strongly curved inwardly, median ones nearly parallel-sided, anteriorly united; clypeus transverse, ridged; HW/PA 1.28; FA/FL 0.58. Antennae shorter than half the body, 1st joint equal to 3rd, 3rd to 5th subequal, 6th to 10th gradually shorter. Pronotum nearly squarish, a little longer than wide, with lateral margins rounded, broadest just below the middle, medially raised; PL/PA 1.35,

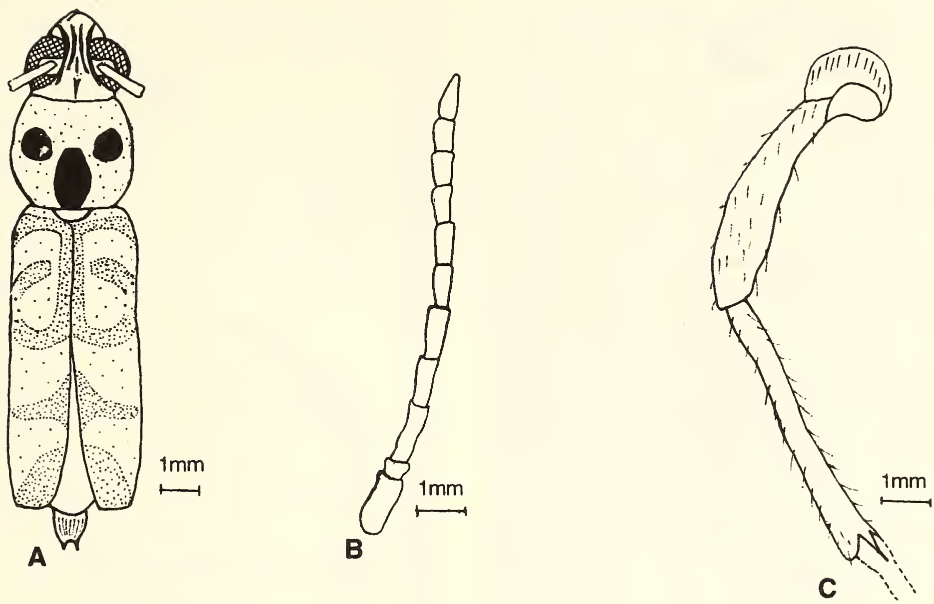

Fig. 6: *Xylotrechus smei* (Lap. et Gory): A. Whole body, B. Antenna, C. Hind leg

PL/PW 0.90, PB/PA 1.0, PB/EW 2.33. Scutellum small, broad, semilunar, densely clothed with white pubescence. Elytra weakly narrowed at apex and truncate apically; EL/EW 8.66; prosternum produced and truncate, metasternum plate-like, midlongitudinally with one black sulcus, basally and apically with transverse bands of white pubescence. Legs moderate, femora thick, hind pair of legs extending a little beyond abdomen, 1st joint of hind tarsus about twice as long as the next two joints united.

Body length: 15 mm.

Material examined: 1 male, SR, B.T.R., Jalpaiguri, West Bengal, 5.iv.1993; 1 male, RB(LT), B.T.R., Jalpaiguri, West Bengal, 20.v.1995.

Distribution: INDIA: Assam, Orissa, West Bengal, North, West, Central and South India (Gahan, 1906), Bhutan; Myanmar; Sri Lanka (Gahan, 1906; Beeson, 1961; Basak and Biswas, 1993).

Tribe: Hesperophanini

Genus: *Stromatium* Serville

Stromatium Serville, 1834, Ann. Soc. Ent. Fr.3: 80.

Type-species: *Callidium barbatum* Fabricius

Stromatium barbatum (Fabricius)

(Fig. 7)

Callidium barbatum Fabricius, 1775, Syst. Ent. : 189.

Male: Red brown to a little darker; faintly covered with orange brown pubescence, 1st joint of antennae brown black, rest red brown, apical segments a little darker.

Head at base narrower than pronotum, densely and rather coarsely punctate, longitudinally sulcate between the antennae; clypeus short, transversely depressed, anteclypeus leathery; HW/PA 1.19, FA/FL 0.69; mandible short, oblique; eyes rather deeply emarginate, with large lower lobe, extending

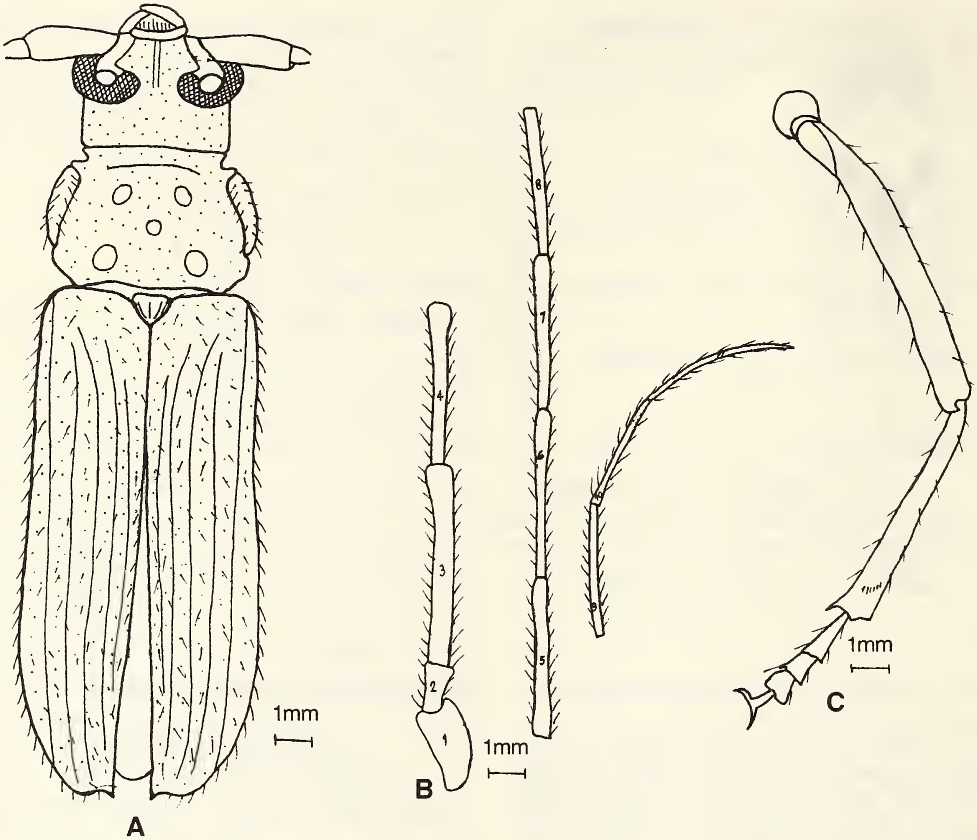

Fig. 7: *Stromatium barbatum* (Fabricius): A. Whole body, B. Antenna, C. Hind leg

anteriorly almost up to the genal edge; antennal tubercles posteriorly raised and bluntly pointed. Antennae 11-segmented, about 1/3 longer than body, with long silky pubescence beneath, 3rd joint longest, 4th slightly shorter than 5th. Pronotum broader than long, subquadrate, with numerous strong coarse punctures; the disc with 5 slightly raised, less distinct tubercles, 2 placed anteriorly, 1 behind middle, and 2 near base, straighter and each marked with a large depression; PL/PA 1.0, PL/PW 0.74, PB/PA 1.0, PB/EW 1.85. Scutellum broadly triangular, with a midlongitudinal depression forming 2 weakly raised lobes on either side. Elytra nearly parallel-sided, narrowed and truncate at apex, coarsely and very densely punctured, each with 2 distinct dorsal and 1 lateral costae, a short sutural tooth at apex; EL/EW 6.57; prosternum weakly sloped at apex. Venters of meso- and metathorax truncate, covered with pubescence, metathoracic plate with median longitudinal black streak; abdominal venters punctate, laterally with rather dense pubescence, medially weakly so. Legs moderately long, femora compressed, fore tibiae very broad a little below the base and gradually narrowed outwards, the middle and hind pairs gradually widened up to the middle; the hind pair nearly reaching elytral apex; 1st joint of the hind tarsus subequal to 2+3, last tarsus with distinct paronychium.

Body length: 21-23 mm.

Material examined: 1 female, RB(LT),

B.T.R., 20.v.1995; 1 male, RM, B.T.R., 30.v.1996; 1 male, NL, B.T.R., 17.v.1997; 1 male, SB(LT), B.T.R., 19.v.1997. All from Jalpaiguri, West Bengal.

Distribution: INDIA: All over; Africa; Bangladesh; Islands of Reunion; Rodriquiz & Seychelles; Pakistan; Malagasy Rep.; Mauritius; Myanmar; North America; Sri Lanka (Gahan, 1906; Beeson, 1961 Khan and Maiti, 1983); England (Beeson, 1961).

Tribe: Oemini

Genus: *Tetraommatus* Perroud

Tetraommatus Perroud, 1855, Ann. Soc. Linn. Lyon (2) ii:390.

Type-species: *Tetraommatus filiformis* Perroud

Tetraommatus filiformis Perroud
(Fig. 8)

Tetraommatus filiformis Perroud, 1855, Ann. Soc. Linn. Lyon (2) ii : 391.

Male: Head, pronotum reddish brown; elytra brown; antennae yellow brown, legs yellow.

Head narrower than pronotum, narrowed at both ends, broadest medially, flat, raised between the antennal sockets, densely and coarsely punctate, sparsely hairy; clypeus transverse, band-like; HW/PA 1.40; FA/FL 0.75; mandibles dark brown, robust, strongly curved, apically broad and truncate; eyes large, deeply emarginate; gula indicated, apically narrowed. Antennae 11-segmented, as long as body, segment III onwards subequal, each at least twice of segment I, sparsely setose. Pronotum subcylindrical, basally broad, anteriorly narrowed, lateral margin sharply rounded towards apex, constricted near base, transversely sulcate striate near middle, densely and finely punctate, sparsely setose; PL/PA 1.40, PL/PW 0.87, PB/PA 1.53, PB/EW 1.76. Scutellum short, broad and obtuse. Elytra parallel-sided, sharply curved towards apex, apically blunt, punctate-striate, sparsely setose; EL/EW 5.70; prosternum between fore coxae short, metasternum medially raised, midlongitudinally with a black sulcus. Legs moderately long, intercoxal part of prosternum very short, front coxae contiguous,

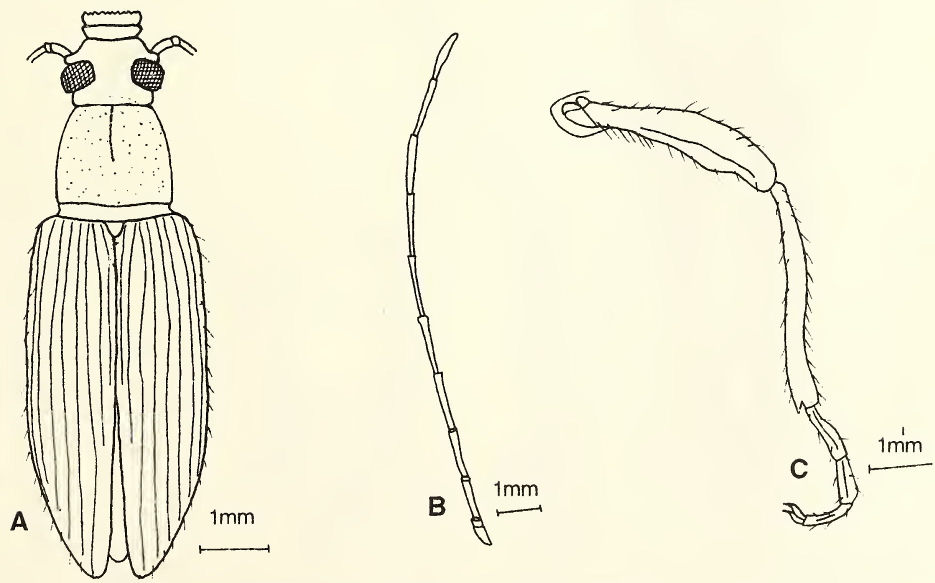

Fig. 8: *Tetraommatus filiformis* Perroud: A. Whole body, B. Antenna, C. Hind leg

with acetabula angulate outwardly and open posteriorly, middle coxae almost contiguous, femora rather long, pedunculate, apically clavate and darker, basally curved, laterally compressed towards apex; tibia basally dark; tarsi long and narrow; 1st joint subequal to the following 3 joints.

Body length: 7-9 mm.

Material examined: 1 male, BG, B.T.R., 25.v.1995; 3 males, TG, B.T.R., 26.v.1996; 2 males, RM, B.T.R., 30.v.1996. All from Jalpaiguri, West Bengal.

Distribution: INDIA: Pondicherry (Gahan, 1906; Beeson, 1961), West Bengal; Sri Lanka (Gahan, 1906 ; Beeson, 1961).

Genus: *Xystrocera* Serville
Xystrocera Serville, 1834, Ann. Soc. Ent. Fr. 3: 69.
Type-species: *Xystrocera globosa* (Olivier)

Xystrocera globosa (Olivier)
(Fig. 9)

Cerambyx globosa Olivier, 1795, Entomologist, 4 (67) : 27.

Male: Reddish brown; pronotum with green metallic bands: along the anterior and posterior margins, midlongitudinally but narrow, and laterally running oblique, joining the fore and hind bands; elytra testaceous yellow, with green metallic bands: the median longitudinal extending obliquely from base, over the shoulder almost to the tip, the outer running from base and at apex turning along the apical margin; head with 2 such rounded spots on either side of the median sulcus of the vertex.

Head at base narrower than pronotum, vertical in front, raised, forming ridges, broadly concave from side to side, between the antennae, densely punctate; antennal supports emarginate in front, acutely pointed on the inner side; vertex densely punctate, midlongitudinally sulcate,

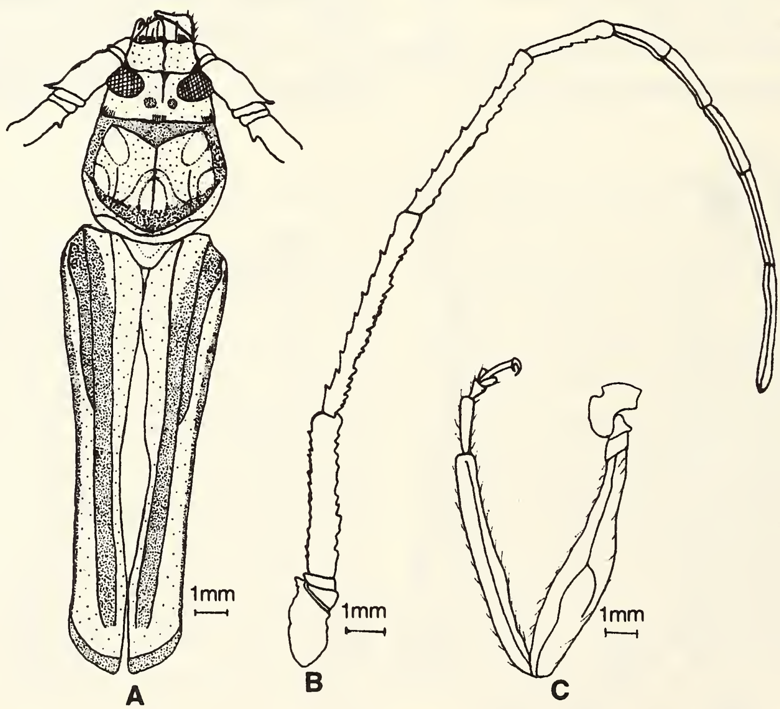

Fig. 9: *Xystrocera globosa* (Olivier): A. Whole body, B. Antenna, C. Hind leg

continuing to the clypeus, laterally weakly emarginate; clypeus transverse, strongly ridged, anteclypeus membranous, postclypeus separated from the front by a transverse groove; HW/PA 1.50; FA/FL 0.83; mandible basally straight, apically turned at right angles, knobbed at point of turning; eyes large, deeply emarginate, the lower lobes extended close to the mandibular edge of the genae. Antennae 11-segmented, about 1/3 to twice as long as the body, first 4 joints strongly warty, margins with blunt spines, these in distal segments greatly reduced and finally obsolete; 1st joint asperate at apex with spines, 3rd to 5th strongly asperate, with the apices thickened and dentate beneath; 3rd joint thicker and about 1/4 shorter than the 4th. Pronotum anteromedially convex, following the transverse depression (~✓), otherwise weakly depressed medially, anterolaterally depressed on both sides, marginally rounded, base with rounded lobe at the middle, entirely strongly warty; PL/PA 1.06, PL/PW 0.85, PB/PA 0.69, PB/EW 3.41. Scutellum tongue-shaped. Elytra long, anteriorly broad, posteriorly narrowed, apex rounded, densely and strongly punctate; each with 3 slightly raised longitudinal striae - 2 dorsal and 1 lateral EL/EW 19.54; prosternum with transverse striate metallic glossy band, close to the front margin, the rest and the sides of the lower part of prothorax form a convexly raised, very minutely and densely punctate dull red area; mesosternum moderately broad, narrowed posteriorly and truncate at tip, metasternum plate-like, with a black median streak. Legs long, fore legs shorter; femora fusiform-clavate, compressed, pedunculate at base, hind femora long; tibiae compressed.

Body length: 23-26 mm.

Material examined: 2 males, RB(LT), B.T.R., Jalpaiguri, West Bengal, 26.v.1995.

Distribution: INDIA: Assam, Karnataka, Maharashtra, Tamil Nadu, West Bengal; Celebes; China; Egypt; Hawaiian Islands; Indonesia; Japan; Korea; Laos; Malaysia; Malagasy Rep.; Mauritius; Myanmar; Philippines; Pacific Island; Taiwan; Thailand; Sri Lanka (Gahan, 1906; Beeson, 1961; Gressitt and Rondon, 1970; Khan and Maiti, 1983).

Tribe: Thraniini

Genus: *Thranius* Pascoe

Thranius Pascoe, 1859, Trans. Ent. Soc. (2) v : 22.

Type-species: *Thranius gibbosus* Pascoe

Thranius simplex Gahan

(Fig. 10)

Thranius simplex Gahan, 1894, Ann. Mus. Civ. Genov., 34 : 15.

Male : Dark brown; head, thorax, abdomen, legs, antennae brown black; antenniferous tubercles, pronotum, scutellum reddish brown; clypeus anteriorly and maxillary palpi yellow.

Head narrower than pronotum, wide transversely, strongly sloped anteriorly, frons flat, subquadrate, midlongitudinally sulcate between the eyes, punctate, vertex transversely depressed below the eyes, clypeus transverse, rectangular, punctate; HW/PA 1.28; FA/FL 0.66; eyes rather transverse, long, weakly emarginate, with upper lobe short, not extending behind the antenniferous tubercles, lower lobe rather prominent inwardly. Antennae 11-segmented, shorter than body, joints cylindrical, 1st joint closely and rather finely punctate, apex rather pale. Pronotum parallel-sided, squarish, basal margin straight, anterior margin weakly concave, lateral margin weakly rounded, medially a little broad, midlongitudinally sulcate, strongly gibbose anteriorly, densely punctate; PA/PL 1.14; PL/PW 0.80, PB/PA 1.28, PB/EW 2.25. Scutellum small, obtuse, scantily punctured. Elytra elongate, almost flat above, deflexed at the sides, narrowed up to the middle, the surface densely punctate, with the front edges of the punctures slightly raised; EL/EW 8.37; prosternum punctate; metathoracic plate with a median longitudinal black streak, its episterna very broad in front, narrowed almost to a point posteriorly. Legs moderately long, femora clavate, with the 1st tarsal joint of hind legs a little longer than 2+3 united.

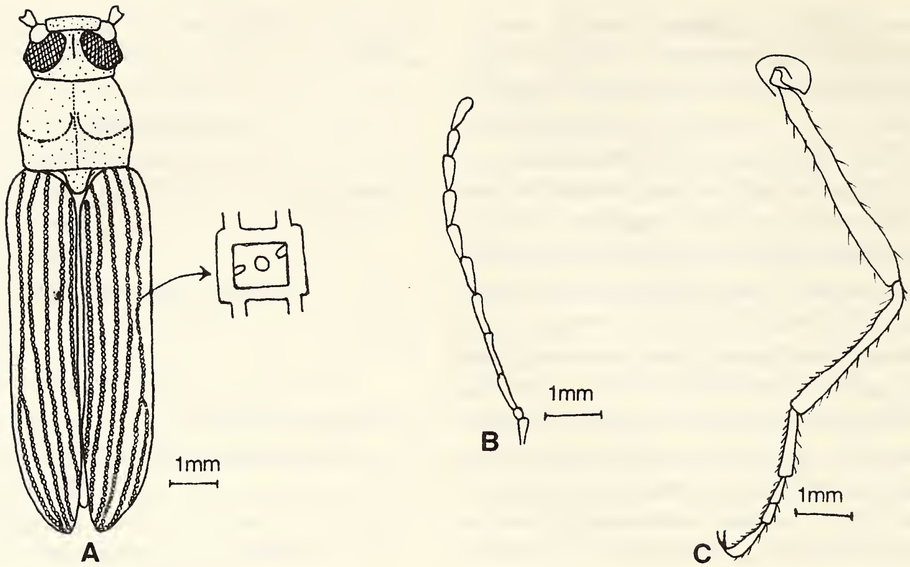

Fig. 10: *Thranius simplex* Gahan: A. Whole body, B. Antenna, C. Hind leg

Body length: 12 mm.

Material examined: 1 male, SB, B.T.R., Jalpaiguri, West Bengal, 20.v.1997.

Distribution: INDIA: Manipur (Gahan, 1906), West Bengal; Bhutan; Myanmar (Gahan, 1906).

Subfamily 2: Prioninae
Tribe: Megopidini
Genus: *Megopis* Serville
Megopis Serville, 1832, Ann. Soc. Ent. Fr. i : 162.
Type-species: *Megopis mutica* Serville

Megopis* (*Aegosoma*) *bowringi (Gahan)
(Fig. 11)

Aegosoma bowringi Gahan, 1894, A.M.N.H. 14 (6): 226.

Male: Reddish brown; densely clothed with short faint brown pubescence, elytral costae free.

Head narrower than pronotum, elongate behind, eyes more or less inclined in front, densely warty and with deeply distinct midlongitudinal black sulcus; vertex flat; frons anteriorly sloped, posteriorly weakly concave; clypeus transverse; HW/PA 0.87; FA/FL 0.59; mandibles short, oblique, toothless; eyes narrowly emarginate in front; gula short, basally broad, anteriorly narrow, either side marked by black ridge. Antennae shorter than body, basal segments densely punctate, apical 3 segments coarsely wrinkled, 1st joint short and stout. 3rd joint longest, subequal to 4+5. Pronotum broadly transverse, wider than long, its warty basal and apical margins nearly straight, lateral margin medially weakly produced, antero-lateral corners weakly produced, rounded, strongly reflexed: PL/PA 0.66, PL/PW 0.59, PB/PA 0.83, PB/EW 2.0. Scutellum nearly globose, densely warty. Elytra broader than pronotum, nearly parallel-sided for the greater part of their length, slightly narrowed posteriorly, rounded at apex, with sutural teeth; EL/EW 8.09; prosternum raised, sloped, on either side extending beyond fore coxae; mesosternum sulcate, midlongitudinally blackish, metasternum broad, plate-like, midlongitudinally with a deeply distinct black sulcus; abdomen ventrally a little paler, densely punctate, segmental joints brown-black, transverse, band-like, clothed with pale brown hairs. Legs moderately long, the hind pair

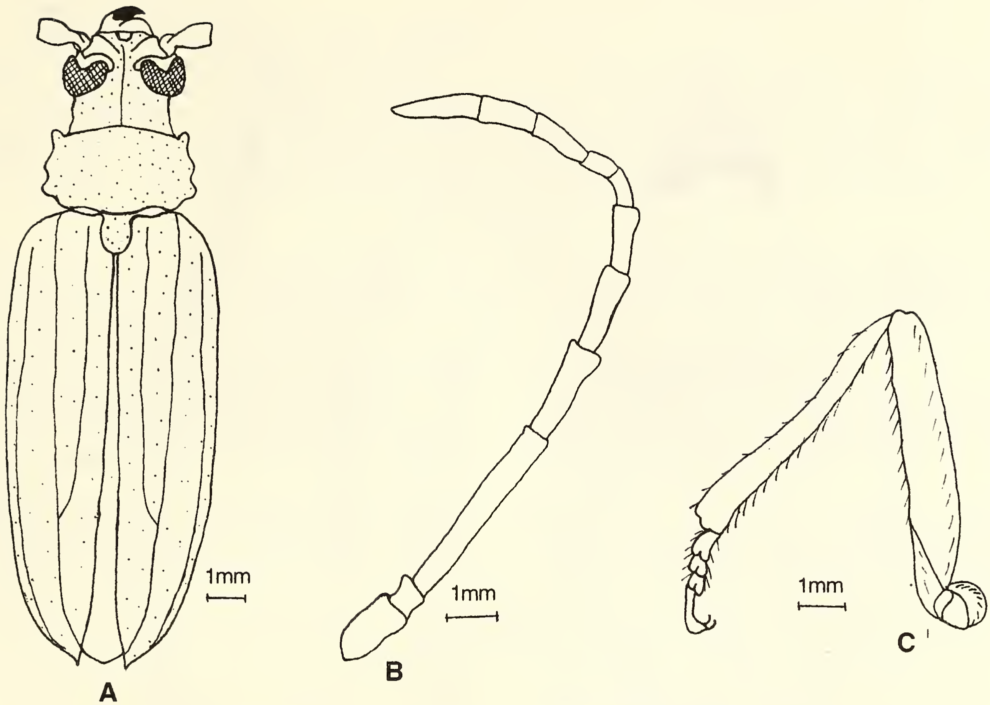

Fig. 11: *Megopis* (*Aegosoma*) *bowringi* (Gahan): A. Whole body, B. Antenna, C. Hind leg

longest, femora laterally compressed, with their dorsal and ventral borders nearly parallel, tarsi rather narrow, with the claw joint at least as long as 1+2.

Body length: 20-23 mm.

Material examined: 1 male, RB, B.T.R., 22.v.1995; 1 male, SB(LT), B.T.R, 19.v.1997. Both Jalpaiguri, West Bengal

Distribution: INDIA: Arunachal Pradesh, West Bengal; Bangladesh; Myanmar (Gahan, 1906).

Tribe: Macrotomini

Genus: *Macrotoma* Serville

Macrotoma Serville, 1832, Ann. Soc. Ent. Fr. 2: 264.

Type-species: *Prionus serripes* Fabricius

Macrotoma* (*Zooblax*) *spinosa Fabricius (Fig. 12)

Prionus spinosus Fabricius, 1787, Mant. Ins. 1 : 130.

Male: Red brown, elytra rusty brown towards base and yellowish towards apex, antennae with three basal segments brown-black, legs reddish, venter glossy red.

Head elongate behind eyes, coarsely punctate between eyes, closely and finely granulate behind, vertex impressed with a median groove; frons punctate, midlongitudinally sulcate due to bulging antennal tubercles, anteriorly vertical and truncate; clypeus depressed, limited above by an impression, weakly punctate; shorter than width of pronotum; HW/PA 0.61; FA/FL 0.76; mandibles vertical, straight at base, incurved at tip, each with 2 teeth on inner edge, punctate; eyes not deeply emarginate on front; venter warty. Antennae 11-segmented, reaching basal 2/3 of elytra, 1st joint apically broad, basally pedunculate, twice as long as broad, closely and coarsely punctate, 3rd segment more than twice

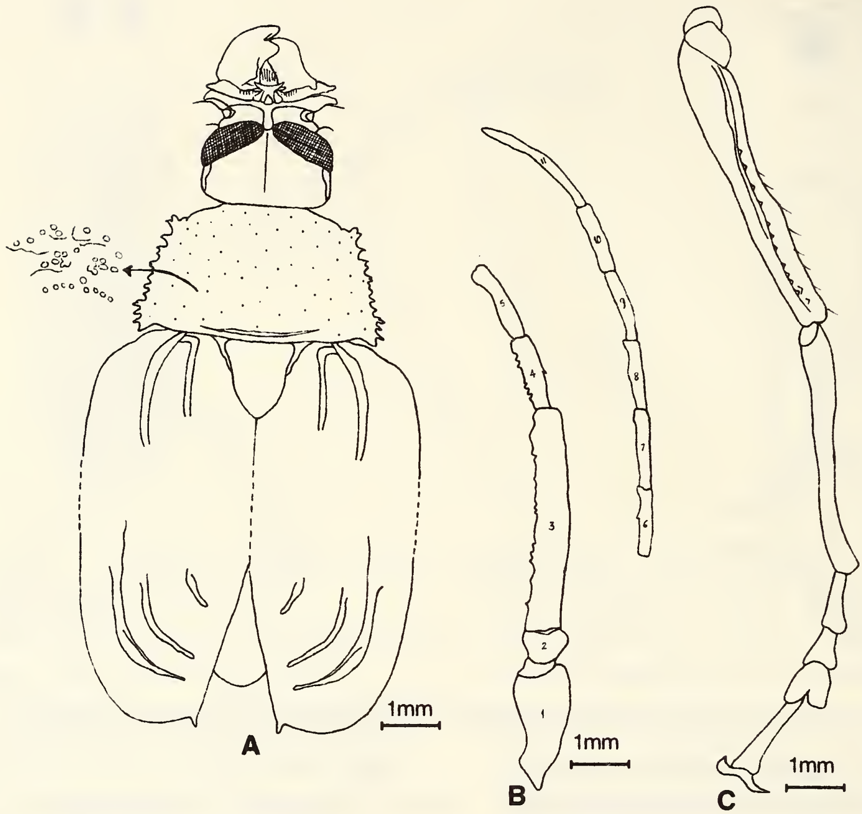

Fig. 12: *Macrotoma* (*Zooblax*) *spinosa* (Fabricius): A. Whole body, B. Antenna, C. Hind leg

as long as 1st, 4th onwards shorter, 11th much longer, spinose beneath and along the front margin, the spines rather short, 4th weakly spinose. Pronotum rather strongly deflexed at sides just before the middle, very closely and finely punctate and opaque, with 2 triangular spaces before the middle, a small spot external to each of these, a narrow transverse band near base, a median streak from the middle and an oblique band from each end of the basal band, all more or less strongly lustrous, lateral edges armed with a series of short spines and teeth, basally broad, apically narrowed; PL/PA 0.80, PL/PW 0.53, PB/PA 1.50, PB/EW 2.14. Scutellum long, tongue-shaped. Elytra much longer than broad, rounded at apex, usually dentate at suture, rugulose-punctate and very finely granulose, the granules more distinct and the surface rough towards base, especially on the slightly elevated part near scutellum, each with 4 longitudinal striae; EL/EW 6.00; prosternum sloped on either side, mesosternum at apex slightly clubbed, metasternum plate-like, medially sulcate with a longitudinal black streak. Legs long, spinose beneath; fore femora and tibiae asperate with short sharp spines beneath, those on mid and hind legs reduced and punctate; middle and hind femora sparsely punctate, armed with a few spines beneath, 1st joint of front tarsus a little shorter than 2+3.

Body length: 56 mm.

Material examined: 1 male, JY(LT), B.T.R., Jalpaiguri, West Bengal, 25.v.1996.

Distribution: INDIA: Bihar, Karnataka (Gahan, 1906), West Bengal; Arabia; Laos; Sri Lanka; (Gahan, 1906; Gressitt and Rondon, 1970).

ACKNOWLEDGEMENTS

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FISHES OF THE CYPRINID GENUS *SEMIPLOTUS* BLEEKER 1859, WITH DESCRIPTION OF A NEW SPECIES FROM MANIPUR, INDIA[1]

WAIKHOM VISHWANATH AND LAISHRAM KOSYGIN[2]

(*With one text-figure and one plate*)

Key words: Cyprinid fish, *Semiplotus*, new species, Manipur

The cyprinid fishes of the genus *Semiplotus* Bleeker are distributed in northern India, Myanmar and Nepal. Four species (including a new one) of the genus are recognised. They are: *S. semiplotus* (McClelland), *S. modestus* Day, *S. cirrhosus* Chaudhuri and *S. manipurensis* sp. nov. This paper describes the new species from the rivers and streams draining Ukhrul dist. of Manipur (Chindwin drainage), India. *Semiplotus manipurensis* differs from *S. semiplotus* and *S. cirrhosus* in having a broader body, fewer branched dorsal rays and several horny tubercles scattered randomly on the snout. It differs from *S. modestus* in having a broader body and an unserrated last dorsal spine. *Semiplotus cirrhosus* is considered a valid species. A key to identification of species of the genus *Semiplotus* is provided.

INTRODUCTION

Bleeker (1859) established the genus *Semiplotus* to accommodate *Cyprinus semiplotus* McClelland, 1839 (type locality: River Brahmaputra, Assam). Day (1870) described another species, *S. modestus* from Akyab in Myanmar and distinguished it from *S. semiplotus* by the serrated last dorsal spine. Later, Chaudhuri (1919) described *S. cirrhosus* based on a single specimen collected from Putao of Myanmar, and distinguished it from the former two species mainly by the presence of two pairs of maxillary barbels and absence of knob at the symphysis of the lower jaw. However, Hora (1973) treated *S. cirrhosus* as a synonym of *S. semiplotus*. Jayaram (1981) included only *S. semiplotus* and *S. modestus* in the genus. The distribution of the genus is restricted to the Himalayan foothills of Nepal, north and northeast India and Myanmar (Fig. 1).

On the basis of its jaw anatomy, Howes (1982) put *Semiplotus* under the genus *Cyprinion* Heckel, 1843. Talwar and Jhingran (1991) recognised *Semiplotus* as a subgenus of *Cyprinion* without justification. However, Banarescu and Herzig (1995) recognised *Semiplotus* as a distinct genus, as it has more branched dorsal fin rays.

No detailed revisional work on this genus has been conducted, and very little is known about the fishes of this genus. This is partly due to the difficulty in obtaining specimens. A brief revision of the genus *Semiplotus* is made here.

MATERIAL AND METHODS

The new species was collected by cast net. Type specimens are deposited in the Manipur University Museum of Fishes (MUMF) and National Science Museum, Tokyo (NSMT). Type and other specimens of *S. cirrhosus, S. modestus* and *S. semiplotus* in Zoological Survey of India, Calcutta were re-examined. Measurements and counts follow Jayaram (1981). Body proportions are expressed as percentage of standard length (SL) and head length (HL). Total number of vertebrae was counted from radiographs and dissected specimens. Transverse scales were counted as scales between lateral line and dorsal fin origin (including mid-dorsal scale)/lateral line scale/ scales between lateral line and pelvic fin origin.

Semiplotus Bleeker, 1859

Semiplotus Bleeker, 1859, *Nat. Tijdschr. Neder.-Indie.* 20: 424 (type species *Cyprinus semiplotus* McClelland, 1839); Banarescu &

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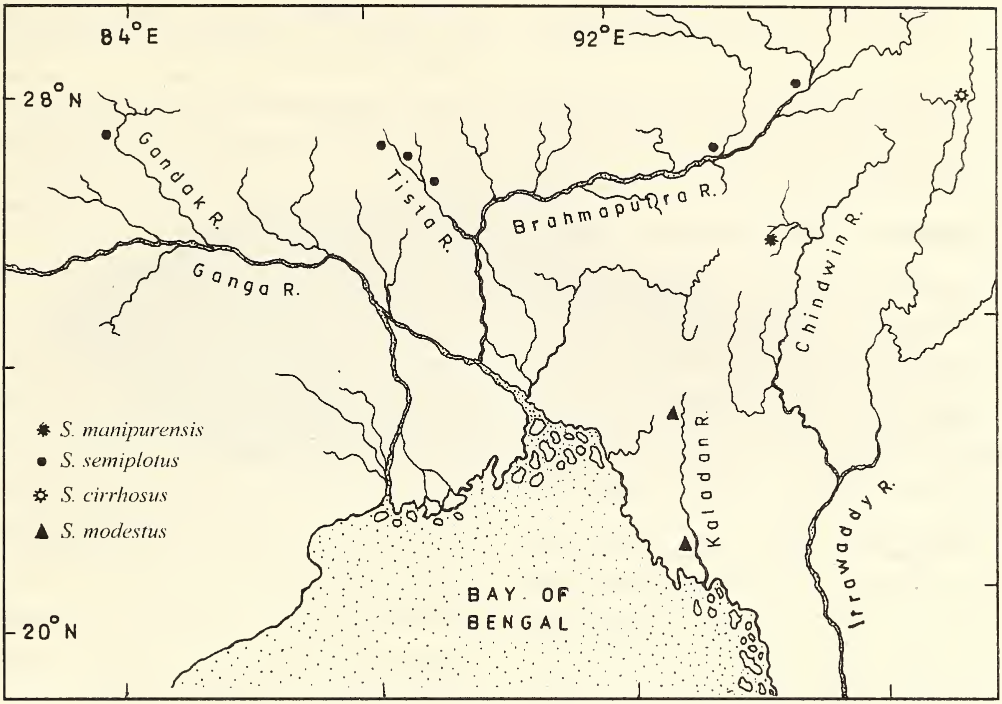


Fig. 1: Drainages of Nepal, northern and eastern parts of India and Myanmar showing the distribution of known species of *Semiplotus*.

Herzig-Straschil, 1995, *Ann. Naturhist. Mus. Wien.*, 97 B: 411 (status discussed).

Diagnosis: A genus of Cyprinidae with the following combination of characters: body large and deep (depth 35.4-41.3% SL); head short, as long as high at occiput (height 93.3-116.1% HL); snout broad, blunt with open pores or tubercles; mouth inferior, wide (width 45.3-65.2% HL) with exposed cornified mandibular cutting edge; dentary with a broad deflected labial surface; maxillary barbel rudimentary; long dorsal fin with 20-25 branched rays; anal fin with 7-9 branched rays; lateral line scales 27-36; lower jaw with a knob at symphysis.

Distribution: INDIA, Ganga-Brahmaputra, Kaladan and Chindwin drainages, Nepal and Myanmar.

Remarks: Banarescu and Herzig (1995) differentiated *Semiplotus* from *Cyprinion* on the basis of (i) more branched dorsal fin rays (20-25 vs. 9-17), (ii) fewer branched anal fin rays (5 vs. 7) and (iii) no barbels. The first character holds true. However, the characters (ii) and (iii) differ from our observations. All the *Semiplotus* specimens studied by us have a pair of small maxillary barbels and 7-9 branched anal fin rays. From the literature it is also observed that *Semiplotus* has more pelvic rays (8-9 vs. 7), fewer scales on lateral line (27-36 vs. 33-45), and a deeper body than *Cyprinion*.

KEY TO THE SPECIES OF GENUS *SEMIPLOTUS* BLEEKER

1a Last simple dorsal ray serrated posteriorly; branched dorsal rays 20-21 .... *S. modestus*

1b Last simple dorsal ray not serrated posteriorly; branched dorsal rays 20-25 2

2a Tubercles on snout randomly distributed on each side of tip of snout; branched dorsal rays 20-23 .... *S. manipurensis*

2b Tubercles/open pores on snout arranged in a transverse row; branched dorsal rays 23-25 3
3a Open pores on snout 4; lateral transverse scales 7/1/4 .... *S. cirrhosus*
3b Open pores on snout 10-12; lateral transverse scales 6/1/4 .... *S. semiplotus*

Semiplotus cirrhosus Chaudhuri, 1919

Semiplotus cirrhosus Chaudhuri, 1919, *Rec. Indian Mus.* 16(4): 280 pl. 22 figs 3, 3a (type locality: Putao plains, Burma); Hora, 1973, *Rec. Indian Mus.*, 39(1): 46 (part).

Material examined: ZSI F 9747/1 holotype, 41.0 mm SL, Myanmar: Putao plains near Tibetan frontier, coll. Murray Stuart, ?.ii.1918

Diagnosis: A species of *Semiplotus* with large eye (diameter 36.2% HL); predorsal length 47.6% SL; a row of 4 open pores (2 on each side) on the snout; the last simple dorsal fin ray not serrated; 25 branched dorsal fin rays; 8 branched pelvic fin rays; 9 branched anal fin rays; a small knob at the symphysis of lower jaw.

Description: Dorsal rays iii, 25; pectoral rays 15; pelvic rays i, 8; anal rays ii, 9; lateral line scales 33; scales above lateral line to origin of dorsal fin 7; scales below lateral line to origin of pelvic fin 4; predorsal scales 13.

Head and body laterally compressed. Snout broad, obtuse, with a row of 4 open pores (2 on each side). Maxillary barbels well developed, extending to below anterior margin of orbit. Eye large, almost in the middle of head. Caudal peduncle deep. Dorsal fin origin slightly nearer snout tip than caudal fin base. Last simple dorsal ray not serrated. Pectoral fin almost reaching pelvic fin origin. Caudal fin forked.

Colour: Head and body silvery with black dorsal surface. Ventral surface dull white.

Distribution: Myanmar: Putao plains (Irrawady drainage).

Remarks: Chaudhuri (1919) described *S. cirrhosus* and differentiated it from other *Semiplotus* by the presence of two small maxillary barbels and the absence of a knob at the symphysis of the lower jaw. Hora (1937) treated *S. cirrhosus* as a synonym of *S. semiplotus* after he found that all other specimens of the genus in ZSI possessed small maxillary barbels. It has not been possible to examine more specimens from Myanmar. However, the holotype of *S. cirrhosus* in ZSI (F9747/1) has been examined. The species differs from *S. semiplotus* as it has fewer pores on the snout [4 (2 on each side) vs. 10-12 (5-6 on each side)]; a longer head (length 26.9% SL vs. 21.9-23.7); larger eye (diameter 36.2% HL vs. 20.8-30.0); longer predorsal length (47.6% SL vs. 39.5-44.2); one more scale row between dorsal fin origin and lateral line (7 vs. 6) and fewer branched pelvic fin rays (8 vs. 9). The anal fin of the holotype is damaged. But Chaudhuri (1919) reported that it had two simple and nine branched rays. Thus, it also differs from *S. semiplotus* as it has more branched anal rays (9 vs. 7). Thus *S. cirrhosus* is treated here as a separate species.

Semiplotus manipurensis sp. nov.
(Plate 1 Figs. 1, 2a)

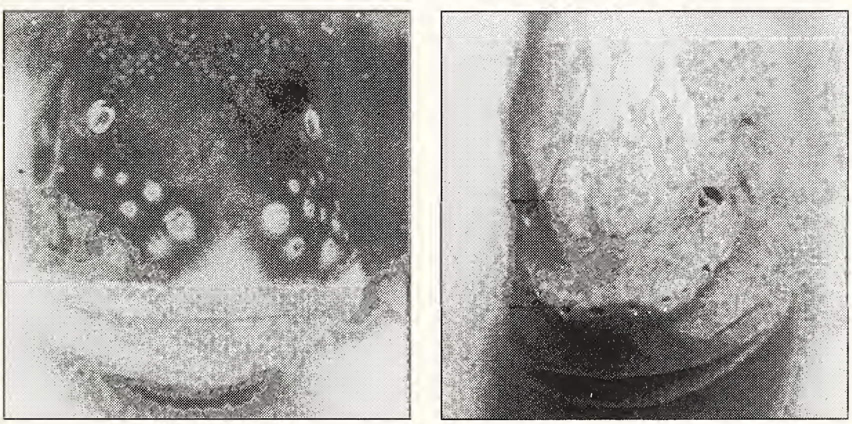
Material examined: Holotype: MUMF 2049, 83.5 mm SL, India: Chall ou river at Thetsi, near Jessami, Manipur (Chindwin basin), 94° 35' E, 25° 38' N, about 1,270 m above msl, coll. L. Kosygin, 2.vi.1994.

Paratypes: NSMT-P 52636, 1 ex., 85.0 mm SL, same data as holotype; MUMF 2011, 2045-2048, 2051-2055, 2145, 2146, 12 ex., 55.3-126.0 mm SL, same data as holotype; MUMF 2236-2240, 5 ex., 42.9-57.5 mm SL, India: Chall ou river, Chingai, Manipur, 94° 31' E, 25° 18' N. 130 km northeast of Imphal, 30.iv.1995; MUMF 2250, 2251, 2 ex., 53.3-185.0 mm SL, India: Wanze stream, Khamsom, Manipur, (Chindwin basin), 116 km northeast of Imphal, 94° 32' E, 25° 12' N, coll. L. Kosygin. 7.vii.1995.

Diagnosis: A species of *Semiplotus* with a broad body (width 17.3-22.1% SL); last dorsal spine not serrated; 20-23 branched dorsal fin

Vishwanath, Waikhom *et al.*: *Semiplotus manipurensis* sp. nov. PLATE 1

Fig. 1 : *Semiplotus manipurensis* sp. nov (holotype, MUMF- 2049, 83.5 mm SL). Scale bar indicates 10 mm



a b

Fig. 2: Front view of snout showing arrangement of tubercles/open pores: a. S. *manipurensis* (MUMF-2251, 185.0 mm SL); b. *S. semiplotus* (ZSIF-2662/2, 181.0 mm SL)

rays; 9 branched pelvic fin rays; 12-13 predorsal scales; dorsal fin base length 34.0-39.7% SL; 32-36 lateral line scales; 7 scale rows between dorsal fin origin and the lateral line; many horny tubercles distributed randomly on each side of snout tip, extending posteriorly to the region below the anterior margin of orbit.

Description: Dorsal rays iv, 20-23 (last ray branched at base); pectoral rays 15-16; pelvic fin rays i, 9; anal fin rays ii-iii, 7-8 (last ray branched at base); principal caudal fin rays 10 + 9; lateral line scales 32-36; scales above lateral line to origin of dorsal fin 7; scales below lateral line to origin of pelvic fin 4; predorsal scales 12-13; total vertebrae 36.

Body short, deep and compressed. Dorsal profile arched from tip of snout to dorsal fin origin and then gently sloping down to caudal fin base. Dorsal profile more convex than ventral. Abdomen edge rounded. Head short and small compared to body depth, almost as long as high at occiput. Snout thick, prominent, broad, obtuse, overhanging the mouth. Snout with horny tubercles distributed randomly on each side, extending to the region below the anterior margin of orbit. Tubercles larger and more prominent towards tip of snout, smaller and less prominent posteriorly. Tubercles not well developed in small specimens (<56.0 mm SL). Number and size of tubercles increasing with total length. Eye large, not visible from below, placed almost in middle of head. Nostrils close to each other, closer to eye than to tip of snout. Mouth wide, transverse, inferior, lower jaw with a knob at symphysis, and an exposed cornified cutting edge. Small maxillary pair of barbels, more prominent in smaller specimens, hardly visible in larger specimens as they are concealed in groove between maxilla and snout. Scales moderate to large, those on chest and abdomen smaller than those of other parts of body. Lateral line complete.

Dorsal fin origin nearer to snout tip than to caudal fin base, extending from a little ahead of pelvic fin to above anal fin base. Last simple dorsal ray strong, osseous and not serrated in large specimens. In small specimens (<130 mm SL), distal third of spine slightly serrated posteriorly. Height of dorsal almost equal to head length. Pectoral fin shorter than head, not reaching pelvic fin origin, latter not reaching anal fin origin. Caudal fin deeply forked with a slightly longer upper lobe.

Colour: Body silvery white, slaty grey dorsally. All fins tinged orange with dusky edges.

Distribution: INDIA: Chall ou river and Wanze stream (Chindwin drainage), Ukhrul District, Manipur.

Etymology: The species is named after the state of Manipur.

Habitat: Moderate to fast flowing hill streams with rocky beds. Smaller specimens inhabit shallow and fast flowing water, while larger ones inhabit deeper waters where water current is comparatively slow.

Remarks: *Semiplotus manipurensis* differs from *S. semiplotus* in its wider body (width at dorsal fin origin 17.3-22.1% SL vs.11.8-16.7), fewer branched dorsal fin rays (20-23 vs. 23-25) and randomly distributed tubercles on either side of the tip of snout vs. a transverse row of open pores on the snout including its tip [all the specimens of *S. semiplotus* in ZSI and the freshly collected specimen (MUMF 2307) from the Brahmaputra river at Dibrugarh, Assam have open pores on snout, while the 21 specimens of *S. manipurensis* have tubercles on snout]; shorter dorsal fin base (34.0-39.7% SL vs. 40.9-44.6); more scales in lateral line (32-36 vs. 27-33) and one more scale row between the origin of dorsal fin and lateral line (7 vs. 6).

The new species is also distinct from *S. cirrhosus* as it has a wider head (63.3-74.2% HL vs. 58.8); wider body (width at dorsal fin origin 17.3-22.1% SL vs.11.1); fewer branched dorsal rays (20-23 vs. 25); smaller eye (diameter 20.0-31.8% HL vs. 36.2); shorter predorsal length (40.8-45.7% SL vs. 47.6); one more branched pelvic fin ray (9 vs. 8); fewer branched anal fin rays (7-8 vs. 9) and many randomly

distributed tubercles on snout (vs. a transverse row of 4 open pores across the snout).

Semiplotus manipurensis is distinct from *S. modestus* as it has fewer predorsal scales (12-13 vs. 14-15); broader body (width at dorsal fin origin 17.3-22.1% SL vs. 9.9%); more branched pelvic rays (9 vs. 8) and last dorsal spine not serrated posteriorly (vs. serrated).

Semiplotus modestus Day, 1870

Semiplotus modestus Day, 1870, *Proc. Zool. Soc. Lond.*: 101 (type locality: Akyab, Burma); Barman, 1988, *J. Bombay nat. Hist. Soc. 85(1)*: 210 (Koladyne R., Mizoram).

Cyprinion modestum: Howes, 1982, *Bull. Brit. Mus. nat. Hist. (Zool), 42(4)*: 331 (status discussed).

Material examined: ZSI 2343, 1 ex., (syntype), 85.4 mm SL, Myanmar: hill ranges near Akyab, coll. F. Day, no date.

Diagnosis: A species of *Semiplotus* with last dorsal spine osseous and serrated posteriorly; 20-21 branched dorsal fin rays; 8 branched pelvic fin rays; 14-15 predorsal scales; 32-34 lateral line scales; and several open pores on either side of snout.

Description: Dorsal fin rays iv, 20-21; pectoral fin rays 15; pelvic fin rays i, 8; anal fin rays iii, 7; principal caudal fin rays 10 + 9; lateral line scales 32-34; scales above lateral line to origin of dorsal fin 7; scales below lateral line to origin of pelvic fin 4; predorsal scales 14-15.

Body deep, laterally compressed. Head short with concave dorsal profile, as long as high at occiput. Snout short, obtuse, overhanging the mouth with several open pores on either side. Maxilla extending below the middle of orbit. Eye large, longer than snout. Dorsal fin origin nearer snout tip than caudal base. Last simple dorsal ray serrated posteriorly. Pectoral fin extends to pelvic fin origin, latter to anal fin. Caudal fin forked, lower lobe slightly longer than upper.

Colour: Silvery grey with black dorsal surface. Pelvic and anal fins orange.

Distribution: INDIA: Kaladan river (Koladyne river as per Barman, 1988), Mizoram; Myanmar: Akyab.

Remarks: The species is quite distinct from other members of the genus *Semiplotus* as it has a posteriorly serrated last dorsal spine.

Semiplotus semiplotus (McClelland, 1839)
(Plate 1 Fig. 2b)

Cyprinus semiplotus McClelland, 1839, *Asiatic Researchers, 19(2)*: 274, 346, pl. 37 fig. 2 (type locality: River Brahmaputra, upper Assam, India).

Semiplotus mcclellandi: Day, 1878, *Fishes of India*: 550 (description).

Semiplotus semiplotus: Hora, 1937, *Rec. Indian Mus.*, 39:45 (part).

Cyprinion semiplotum: Howes, 1982, *Bull. Brit. Mus. nat. Hist. (Zool), 42(4)*: 331, figs 1a-c (Jaw structure studied, status discussed).

Material examined: MUMF 2307, 1 ex., 131.4 mm SL, India: Brahmaputra river, Dibrugarh, Assam, coll. L. Kosygin, 22.x.1995; ZSI F 2861/2 1 ex., 162.0 mm SL, India: Darjeeling Himalayas, coll. G.E. Shaw & E.O. Shebbeare, 28.iii.1937 ZSI F 2662/2, 3 exs. 89.7-181.0 mm SL, India: Tista drainage, S.L. Hora, ?.xi.1938.

Diagnosis: A species of *Semiplotus* with last simple dorsal fin ray not serrated; 23-25 branched dorsal fin rays; a transverse row of 10-12 open pores (5-6 on each side) across the snout posteriorly directed toward middle of orbit.

Description: Dorsal fin rays iv, 23-25; pectoral fin rays 15-16; pelvic fin rays i, 9; anal fin rays ii, 7 (last ray branched at base); principal caudal fin rays 10 + 9; lateral line scales 27-33; scales above lateral line to origin of dorsal fin 6; scales below lateral line to origin of pelvic fin 4; predorsal scales 11-12.

Head and body deep, laterally compressed, with convex dorsal profile. Snout blunt with a very distinctive transverse row of 10-12 (5-6 on each side) open pores across it. Posteriorly open

TABLE 1

MORPHOLOGICAL CHARACTERS OF *S. MANIPURENSIS*, *S. SEMIPLOTUS*, *S. CIRRHOSUS* AND *S. MODESTUS*

	S. manipurensis				*S. semiplotus*				*S. cirrhosus* Holotype ZSI F 9747/1	*S. modestus* Syntype ZSI 2343
	Holotype MUMF 2049	Paratypes NSMT-P 52636, MUMF 2011, 2045-2048, 2051-2055,2145,2146 2236-2240 2250-2251			MUMF 2307	ZSI F 2861/2, 2662/2, 13403/1				
N		20			1	10				1
		min - max	mean	s.d.		min - max	mean	s.d.		
In % of Standard length										
Head Length	24.6	23.2-26.9	24.9	1.0	23.4	219-23.7	22.9	0.7	26.9	23.9
Body Depth	39.5	35.7-41.3	38.4	1.6	37.5	35.4-41.2	38.6	1.9	36.3	40.8
Body width	20.1	17.3-22.1	19.2	1.5	14.8	11.8-16.7	13.6	1.5	11.1	9.9
Predorsal length	43.8	40.8-45.7	44.1	1.5	42.2	39.5-44.2	41.0	1.4	47.6	44.0
Prepectoral length	21.3	20.2-25.4	22.5	1.3	20.6	20.1-22.5	21.6	1.1	26.8	23.1
Prepelvic length	46.9	45.0-48.9	47.3	1.3	44.9	45.4-46.0	45.8	0.5	50.7	48.6
Preanal length	70.7	69.4-73.7	71.9	1.6	72.2	74.7-77.0	75.5	1.3	73.2	48.6
Distance between pectoral & pelvic fin origins	28.0	24.0-28.9	26.7	1.5	23.5	25.2-27.9	25.9	0.8	28.1	26.1
Distance between pelvic & anal fin origins	27.3	24.0-27.3	25.3	1.1	28.0	25.8-31.2	28.0	1.8	24.4	24.6
Length of dorsal fin base	38.2	34.0-39.7	36.9	1.9	42.2	40.9-44.6	42.2	1.5	35.1	37.0
Height of dorsal fin	25.9	24.2-26.1	25.2	0.6	24.4	22.4-25.4	23.9	0.9	22.4	24.3
Length of pectoral fin	21.8	20.7-23.4	21.7	0.7	23.6	22.0-24.0	22.6	0.6	23.7	25.6
Length of ventral fin	20.8	19.6-21.9	20.6	0.7	24.1	20.4-23.5	21.9	0.9	19.5	24.7
Length of anal fin base	11.6	10.0-11.9	11.0	0.6	11.8	10.3-12.4	11.2	0.6	10.9	12.2
Height of anal fin	20.8	18.1-23.1	19.9	1.3	22.1	20.0-25.9	22.2	1.8	damaged	23.9
Length of caudal fin	34.7	31.1-37.5	34.5	1.7	32.5	30.7-31.6	31.2	0.6	damaged	damaged
Length of caudal peduncle	20.1	17.9-22.3	20.1	1.1	20.2	18.9-20.2	19.4	1.0	21 7	19.2
Height of caudal peduncle	11.9	1.1-12.5	11.9	0.3	11.8	10.7-11.9	11.3	0.5	12.9	11.6
Height of head at occiput	97.6	93.3-100.0	95.8	2.2	97.4	95.2-116.1	103.5	5.9	100.0	98.0

TABLE 1 (*contd.*)

MORPHOLOGICAL CHARACTERS OF *S. MANIPURENSIS*, *S. SEMIPLOTUS*, *S. CIRRHOSUS* AND *S. MODESTUS*

	S. manipurensis				*S. semiplotus*				*S. cirrhosus*	*S. modestus*
	Holotype MUMF 2049	Paratypes NSMT-P 52636, MUMF 2011, 2045-2048, 2051-2055,2145,2146 2236-2240 2250-2251			MUMF 2307	ZSI F 2861/2, 2662/2, 13403/1			Holotype ZSI F 9747/1	Syntype ZSI 2343
N		20			1	10				1
		min - max	mean	s.d.		min - max	mean	s.d.		
Head width	71.7	63.3-742	67.7	3.6	65.2	58.8-76.1	65.2	6.6	58.8	62.0
Snout length	34.2	28.7-39.6	31.4	2.5	35.2	30.1-38.2	34.7	3.0	29.4	25.0
Eye diameter	27.3	20.0-31.8	27.7	2.7	21.2	20.8-30.0	26.1	2.9	36.2	32.8
Interobital space	43.9	37.2-46.7	41.7	3.3	47.6	43.4-48.8	46.6	3.4	40.7	49.5
Mouth width	52.2	47.0-61.5	52.3	5.3	60.9	52.6-65.2	57.8	4.4	45.3	50.5
Pectoral length	88.8	82.1-96.9	87.5	5.0	100.0	95.4-107.6	99.1	4.1	87.8	107.4
Counts										
Dorsal fin rays	IV, 22	IV, 20-23			IV, 24	IV, 23-25			III, 25	IV, 20
Pectoral fin rays	16	15-16			15	15-16			15	15
Ventral fin rays	i, 9	i, 9			i, 9	i, 9			i, 8	i, 8
Anal fin rays	iii, 7	ii-iii, 7-8			ii, 7	ii, 7			damaged	iii, 7
Predorsal scales	12	12-13			11	11-12			13	14
Lateral line scales	33	32-36			31	29-31			33	32
Lateral transverse scales	7/1/4	7/1/4			6/1/4	6/1/4			7/1/4	7/1/4
Pores/tubercles on snout	scattered, many	scattered, many			10 in a row		10-12 in a row		4 in a row	4+4 scattered

TABLE 2

FREQUENCY DISTRIBUTION OF COUNTS OF *S. MANIPURENSIS*, *S. SEMIPLOTUS*, *S. CIRRHOSUS* AND *S. MODESTUS*

Name of species	Branched dorsal fin rays						Branched anal fin rays			Lateral line scales								Predorsal scales			
	20	21	22	23	24	25	7	8	9	29	30	31	32	33	34	35	36	11	12	13	14
S. manipurensis	2	8	7	4	-	-	18	3	-	-	-	-	5	10	3	2	1	-	6	15	-
S. semiplotus	-	-	-	3	5	3	11	-	-	2	6	3	-	-	-	-	-	7	4	-	-
S. cirrhosus	-	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-
S. modestus	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	1

pores directed towards middle of orbit. Eye moderate, almost in middle of head. Mouth wide, inferior, lower jaw with a horny layer. Barbels a small maxillary pair, more prominent in smaller specimens. Dorsal fin high, with long base. Last dorsal simple ray strong, osseous, not serrated in large specimens but slightly serrated in distal half in juveniles. Pectoral fin equal to head, almost reaching pelvic fin origin. Pelvic fin shorter than pectoral, not reaching anal fin. Caudal fin forked.

Colour: Dull silvery with black dorsal surface. Pectoral, pelvic and anal fins orange.

Distribution: INDIA: Arunachal Pradesh, Assam (Brahmaputra drainage), north Bengal; Nepal: Terai (Ganga drainage).

Remarks: According to Day (1878), the species is often termed Rajah-mas (King fish) in upper Assam, as it was asserted that when captured it had to be taken to the Rajahs for their own consumption. He also remarked on the statement of McClelland that the fish attained at least two feet in length and was reckoned the most delicious in Assam. Menon (1989) included *S. semiplotus* in the list of endangered freshwater fishes of India. The underutilised hill stream fishes of Nepal were listed by Shreshtha (1997), who included this species, and suggested the possibility of developing recreational fishery of these fishes in Nepal.

Discussion

Most workers (Bleeker, 1859; Günther, 1868; Day, 1878; Jayaram, 1981; Barman, 1988) erroneously considered that *Semiplotus* lacks barbels. However, Hora (1937) examined all the specimens of *Semiplotus* in ZSI and a specimen from Nepal collected by Col. Bailey, and concluded that the presence of small maxillary barbels is a constant feature of the genus. He further remarked that in young specimens barbels are longer and project outside the groove, whereas in half-grown and adult specimens they are more or less concealed, though it is not very difficult to make them out. This statement of Hora (*op. cit*) holds true for the present study, as all the specimens of *Semiplotus* examined (including the type specimens of *S. manipurensis*) have a small pair of maxillary barbels. Thus the presence of a small pair of maxillary barbels is a distinct character of the genus *Semiplotus*.

Interesting observations have been made in the ichthyogeography of *Semiplotus* species which are endemic in Southeast Asia. McClelland (1839) originally described *S. semiplotus* from the Brahmaputra river, upper Assam. Day (1878) put the fish under *S. mcclellandi* and reported that it inhabited the rivers of Assam, especially in the upper portion but was also found as low as Goalpara and in Myanmar. Günther (1868) on the other hand mentioned only Assam as the place of its distribution. Mukerji (1933) included this species in the list of fishes of Mali Hka river, upper Myanmar without giving a systematic account. As there is no specimen of the fish collected by either F. Day or D.D. Mukerji in ZSI (although they are supposed to be there), it is difficult to establish the correct identity of the species and its distribution in Myanmar. Hora (1937) reported this fish from the Nepal terai which is drained by tributaries of the Ganga. Thus, *S. semiplotus* is perhaps present only in the Ganga-Brahmaputra drainage. On the other hand *S. cirrhosus* and *S. manipurensis* share the Chindwin-Irrawaddy drainage, which is entirely separate from the Brahmaputra drainage (Chaudhuri, 1919). Further, distribution of *S. modestus* is totally isolated from other species of the genus. The species is distributed in Akyab of Myanmar and parts of Mizoram (India) which are drained by the Kaladan drainage which enters the Bay of Bengal directly. Kaladan drainage is separated from the Barak-Brahmaputra drainage of India by the Chittagong hill tract. The region is also separated from the Chindwin-Irrawaddy drainage of Myanmar by the north-south

extension of the Arakan Yoma hill range. From the above statements it is clear that *Semiplotus* is distributed in north India, Myanmar and Nepal, with restricted distribution in different drainages. A detailed study of the geological history of the region may give a true picture of the phylogeny of these fishes.

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FOOD AND FEEDING HABITS OF INDIAN BARBETS, *MEGALAIMA* SPP.[1]

HAFIZ S.A. YAHYA[2]

(*With three text-figures*)

Key words: Barbets, congeneric, sympatric, food, feeding method, ecological isolation, coexistence, conservation.

A comparative study on the ecology and biology of Indian barbets (*Megalaima* spp.) was carried out between 1977 and 1980 in different parts of the country. *Megalaima viridis* and *M. rubricapilla malabarica* were studied more intensively at Thekkady (Kerala), while *M. virens, M. zeylanica, M. lineata, M. asiatica, M. franklinii* and *M. haemacephala* were studied at other places. The findings on the feeding behaviour of the barbets are discussed in this paper. Data on food items, fruiting seasons, abundance of fruiting trees, feeding method and extent of ecological isolation in food habits of coexisting species are discussed. The barbets are predominantly frugivorous, but during the breeding season all species feed their young with insects. Among the congeneric sympatric *M. viridis* and *M. rubricapilla* at Thekkady, the former was found to be more insectivorous, helping considerably in checking the deadly teak defoliator *Hyblaea puera.* Contrary to reports of *M. zeylanica* and *M. viridis* being minor pests on coffee, they were found to be quite helpful to coffee plants in picking up the coffee stem borer, *Xylotrechus quadripes.* Barbets also help in seed dispersal and pollination of scores of trees, and thus play an important role in maintaining the rich biodiversity of the country, and they deserve conservation priorities.

INTRODUCTION

The name barbet is derived from the French *Barbu* (=bearded) which is suggested by the presence of nasal and rictal bristles. They are closely related to Old World honeyguides (Indicatoridae) and the New World puff birds (Bucconidae). The barbet family Capitonidae has a pantropical distribution. Ripley (1961) reported 10 species from the Indian subcontinent under the single genus *Megalaima.*

According to Simmons (1970), food supply plays an important role in determining the breeding biology, dispersion pattern and social system of a species through natural selection. In this paper, apart from mentioning the main food items, fruiting seasons and abundance of fruiting trees at Thekkady, the food and feeding methods of coexisting *M. viridis* and *M. rubricapilla* are described to ascertain the extent of isolation in food habits. Food habits of *M. zeylanica* and *M. haemacephala* are also discussed briefly. The impact of food habits of *M. viridis* on coffee plantations was assessed and has been published elsewhere (Yahya 1982). Barbets do not drink water regularly, but they were often recorded drinking water and bathing from the rain filled natural tree holes. Drinking and bathing behaviour have been described elsewhere (Yahya 1991).

The study was carried out mainly in the Periyar Tiger Reserve (9° 30' N lat. and 77° 10' E long.) Kerala, consisting of evergreen, semi-evergreen, shola, moist-deciduous and savanna forests. Details of the study area have been published earlier (Ali 1935, Yahya 1980, 1988, 1989, Vijayan 1984, and Robertson and Jackson 1992). Comparative studies were made at several other locations.

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On reconnaissance, it was found that moist deciduous forest was favoured most by the barbets (Yahya 1989). Therefore, Thekkady – a small area of moist deciduous forest, 3 km in length and an average of 0.5 km wide, was selected for intensive study. A road of about 4 km passes through the middle of the forest connecting the reserve to the nearby town Kumily. There are several buildings in this area, besides a picnic spot and a caravan park.

Methods

Barbets were observed in their natural condition for about three years to study various aspects of their ecology and biology. Data was collected on food and feeding habits between April 1978 and April 1979.

Each day was divided into three 4-hour shifts; 0600 to 1000 hrs, 1000 to 1400 hrs and 1400 to 1800 hrs. Observations were made on alternate shifts. On two days in each month, barbets were followed for the whole day. Fruiting of trees was recorded each month by trekking through different routes in the study area at least every fifth day.

The data collected included food items, heights at which the birds fed, number of birds feeding at that time and any antagonistic behaviour. Barbets are mostly arboreal birds and only on five occasions did I note *M. viridis* searching for food on the ground. Hence, the vertical height distribution of feeding zone was divided into three broad levels: Primary level 1 to 4 m, Secondary level 4 to 8 m and Tertiary level above 8 m. In the beginning, I tried to distinguish different canopies at which the birds fed, but this was not done later as both species were found exploiting the canopy equally.

The total numbers of each species of barbet recorded feeding on different fruiting trees and hunting insects were considered during the final analysis. As barbets hunt in the brighter hours of the day and in exposed areas, it was possible to identify such prey as cicadas, leafhoppers, ants, termites, butterflies, spiders, beetles and caterpillars. But barbets were seen to be primarily frugivores, and easy to observe visually, therefore no specimen was collected for stomach analysis. The data gathered from April 1978 to April 1979 are analysed here. During this period, a total of 3,346 *M. viridis* and 1,889 *M. rubricapilla* were recorded feeding.

Fruiting season and relative abundance of fruit trees in the intensive study area

Fruiting/flowering seasons of the principal trees/shrubs on which barbets were found feeding/sipping and relative abundance of fruiting trees in the intensive study area are shown in Tables 1 and 2 respectively.

Table 1

RELATIVE ABUNDANCE OF DIFFERENT SPECIES OF FRUITING/FLOWERING TREES VISITED BY BARBETS FOR FOOD IN THE STUDY AREA

(3 km x ½ km)

Plant species	Relative abundance			
	<5	5 to 10	10 to 15	>15
Actinodaphne hookeri				x
Bischofia javanica	x			
Bridelia retusa		x		
Bombax ceiba			x	
Careya arborea	x			
Erythrina sp.				x
Eucalyptus sp.				x
Evodea lunuankenda				x
Ficus gibbosa		x		
F. infectoria	x			
F. insignis	x			
F. mysorensis		x		
F. retusa		x		
F. tsiela				x
Grewia tiliaefolia				x
Lantana camara				x
Leea indica				x
Machilus macrantha			x	
Macaranga sp.				x
Olea dioica			x	
Santalum album				x
Scolopia crenata		x		
Solanum indicum				x
Spathodea campanulata			x	
Syzygium cumini		x		
Ziziphus sp.	x			

TABLE 2
FRUITING/FLOWERING SEASONS* OF PRINCIPAL TREES AND SHRUBS ON WHICH BARBETS FEED

Plant species		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Oct	Nov	Dec
Actinodaphne hookeri					x	x	x	x				
Bischofia javanica		x										x
Bridelia retusa									x	x	x	
Bombax ceiba		x	x	x							x	x
Careya arborea				x	x							
Erythrina sp.		x							x	x	x	x
Eucalyptus sp.								x	x	x	x	
Evodea lunuankenda		x									x	x
Ficus gibbosa		x	x	x	x						x	x
F. infectoria		x									x	x
F. insignis								x			x	x
F. mysorensis		x	x	x			x	x	x	x	x	x
F. retusa		x	x	x	x	x	x		x	x	x	x
F. tsiela		x	x	x	x	x	x	x	x	x	x	x
Grewia tiliaefolia						x	x	x	x			
Lantana camara		x	x	x	x	x	x	x	x	x	x	x
Leea indica						x	x	x	x	x	x	x
Machilus macrantha			x	x	x							
Macaranga sp.			x	x	x	x					x	x
Olea dioica					x	x						
Santalum album					x	x				x		
Scolopia crenata					x	x						
Solanum indicum	x	x	x	x	x	x	x	x	x	x	x	x
Spathodea campanulata							x	x	x	x	x	
Syzygium cumini				x	x							

*As recorded between April 1978 to July 1979; no data for September 1978.

Almost all the trees except some *Ficus* fruit annually at Thekkady. Though the fruiting period varies from species to species and at times from one individual to another, there appear to be two peak periods of fruiting, April-June and November-December. However, during April-June 1979, comparatively few species of trees were recorded fruiting. This could be due to lower rainfall in the previous year, as the fruiting period of the same tree may vary from year to year due to rainfall and other climatic factors.

During April-June *Actinodaphne hookeri, Ficus gibbosa, F. tsiela, Grewia tiliaefolia, Machilus macrantha, Macaranga* sp., *Olea dioica, Santalum album, Scolopia crenata* and *Syzygium cumini* were the main fruiting trees.

During November-December, different species of *Ficus* were the main fruiting trees. Some other tree species also start flowering. From the flowers of *Erythrina indica, Bombax ceiba* and *Spathodea* sp., only *M. viridis* was seen sipping nectar. Among these, *Erythrina* flowers for an extended period of 5 months, mainly October to February, *Bombax* flowers from November to February and *Spathodea* mainly during June to August, though some trees were found flowering as late as November. *Bischofia javanica* fruits from November to January, whereas, *Bridelia retusa* fruits from August to November.

Fruits of *Lantana camara* and *Solanum indicum* comprise the regular food of *M. viridis*. These plants fruit almost throughout the year. *Leea indica*, on which only *M. viridis* feeds, fruits for a long period of 8 months (May to December), some trees with a few fruits are found in other months also (Table 2).

The fruit abundance in this region from April to June appears to be a reciprocal adaptation with the breeding season of local birds. Most of the resident birds breed during this period (Yahya 1988) and thus the chances of seed dispersal are maximum.

Ficus trees provide the maximum quantity and variety of food to barbets. *Ficus tsiela* and *F. retusa* are more versatile and one or other of these species may be found fruiting throughout the year. However, no fruit was recorded on *F. retusa* in July-August. *Ficus mysorensis* and *F. insignis* were recorded fruiting during the rainy months, whereas *F. gibbosa* commonly fruits during drier months. *F. hispida* and *F. glomerata*, which were found fruiting invariably throughout the study area (the former at Thekkady and the latter at Lowercamp, Tamil Nadu) were never eaten by either species. At Sanjay Gandhi National Park, Mumbai *M. zeylanica*, were observed at times pecking at the ripe receptacles of *F. glomerata*, but never successfully, as the fruit fell down before the bird could pluck it. This could be due to the very weak peduncle of the ripe receptacle. However, near Churchgate, Mumbai, I found *M. haemacephala* pecking bit by bit on the semi-ripe receptacle of *F. glomerata*, but on no occasion did I find any barbet feeding on *F. hispida*).

Comparatively few species of trees fruit during February and March at Thekkady. This could be due to the deciduous nature of the dominant species. During this period, almost all the trees shed their leaves, the rain is comparatively meagre, and most of the trees prepare for the forthcoming fruiting season. According to Champion and Seth (1968) the seasonal distribution of rainfall has a far-reaching influence on the nature of vegetation.

Results and Discussion

The ratio of consumption of animal and plant matter by *M. viridis* and *M. rubricapilla* is almost similar in every month (Fig. 1 & 2), except during the nesting period (March-July) for *M. viridis* which then consumes a larger quantity of animal matter. This could be due to the marked difference between the nestlings' food in the two species (Yahya 1980, 1988).

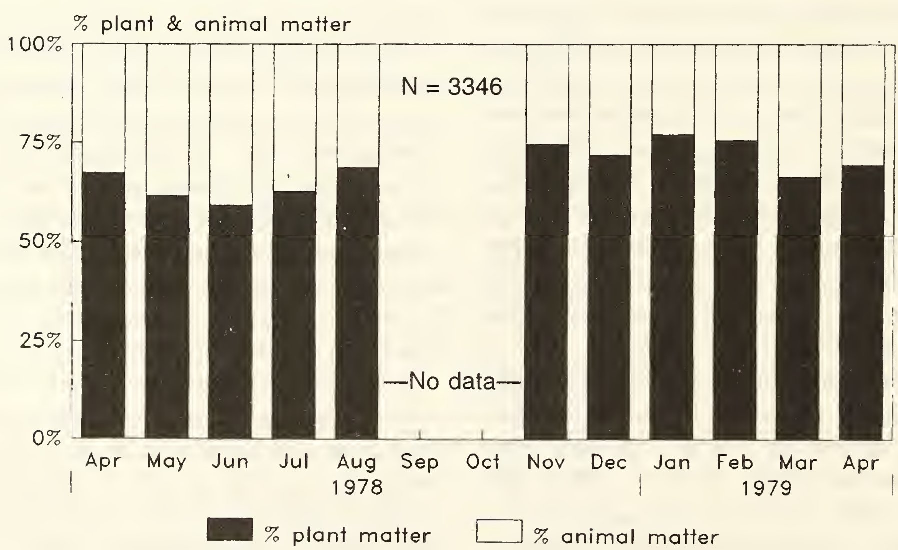


Fig. 1: Monthly feeding pattern of *M. viridis*

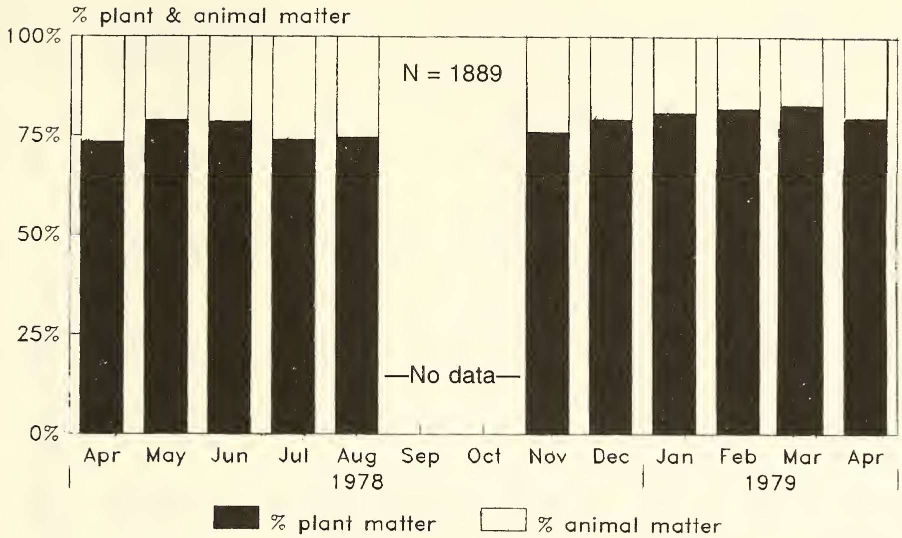


Fig. 2: Monthly feeding pattern of *M. rubricapilla*

Plant matter consumed by *M. rubricapilla* was restricted to fruits, and was about 8% more than that of *M. viridis*. However, the latter is a more versatile vegetarian, feeding on a wider range of vegetable matter. While *M. viridis* often feeds on the nectar of various flowers, *M. rubricapilla* was never found to do so.

Though predominantly frugivores, both *M. viridis* and *M. rubricapilla* also feed on a large amount of animal matter, the former consuming about 10% more than the latter (Table 3). Animal food items consumed by *M. viridis* were larger in size and more diverse than those of *M. rubricapilla*. *M. viridis* feeds on earthworms (seen only twice) butterflies, dragonflies, mantids, cicadas, beetles, spiders, termites and caterpillars, whereas *M. rubricapilla* restricts itself to smaller caterpillars, borer larvae, termites and ants. Though the food preferences of these congeneric species are distinguishable, their feeding niches and food often overlap.

Vegetable food of *M. viridis* and *M. rubricapilla*

As shown in Table 4, *M. viridis* and *M. rubricapilla* both show a preference for certain fruits in each month, but many fruits favoured by one species are frequently taken by the other also. Before analysing the data for a possible explanation of how these two congeneric sympatric species manage to coexist in the same habitat, a broad outline of their month-wise food items and preferences is given briefly.

During January-February when only a limited number of trees are fruiting, *M. viridis* very frequently forages on shrubs, while *M. rubricapilla* restricts itself to certain *Ficus* species. The common trees, on which the feeding of both species considerably overlaps during this period, are *Ficus mysorensis*, *F. retusa*, *F. gibbosa*, *F. infectoria* and *F. tsiela*. Among these, *M. rubricapilla* shows a much higher preference for *F. gibbosa*, *F. tsiala* and *F. retusa*,

TABLE 3
PERCENTAGE OF BARBETS FEEDING ON PLANT/ANIMAL MATTER

Species	No. of individuals	
	Fruit/nectar	Insects
M. viridis (n = 3346)	2352 – 70.29%	994 – 29.71%
M. rubricapilla (n = 1889)	1485 – 87.61%	404 – 21.39%

TABLE 4
*PERCENTAGE OF *M. VIRIDIS* AND *M. RUBRICAPILLA* FEEDING ON FRUITS/NECTAR

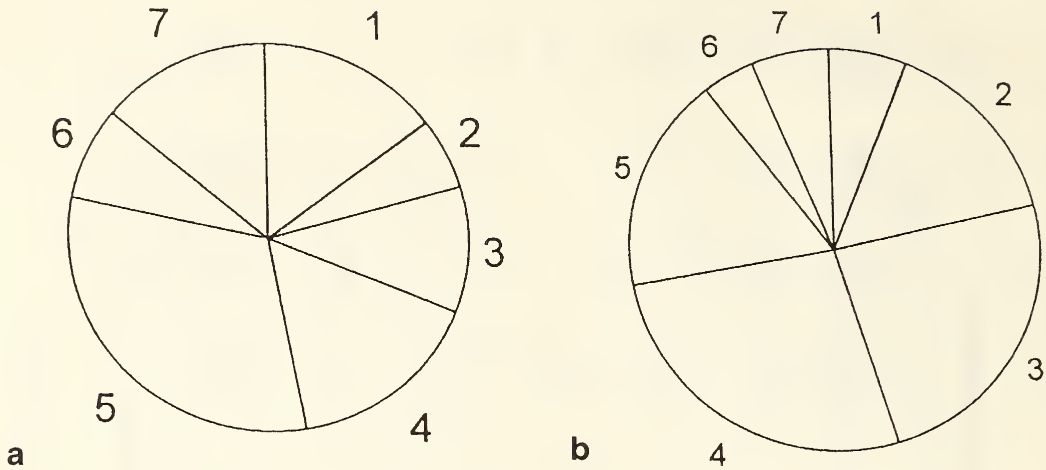
	1978							1979			
	Apr	May	Jun	Jul	Aug	Nov	Dec	Jan	Feb	Mar	Apr
Actinodaphne hookeri	13.88	12.97	9.77	7.62	-	-	-	-	-	-	-
	4.61	7.21	7.64	5.78	-	-	-	-	-	-	-
Bischofia javanica	-	-	-	-	-	-	3.30	4.70	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Bridelia retusa	-	-	-	-	5.43	1.25	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Bombax ceiba	-	-	-	-	-	0.62	3.37	12.82	2.36	-	-
	-	-	-	-	-	-	-	-	-	-	-
Careya arborea	2.44	-	-	-	-	-	-	-	-		-
	-	-	-	-	-	-	-	-	-	-	-
Erythrina sp.	-	-	-	-	1.81	3.95	2.86	0.85	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus sp.	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	6.76	6.14	1.14	-	-			
Evodea lunuankenda	-	-	-	-	-	0.02	1.85	2.56	-	-	-
	-	-	-	-	-	0.85	0.83	1.48	-	-	-
Ficus gibbosa	6.12	-	-	-	-	2.08	3.03	-	6.73	-	-
	-	-	-	-	-	13.78	14.52	5.19	30.45	-	-
F. infectoria	-	-	-	-	-	2.08	23.91	2.56	-	-	-
	-	-	-	-	-	5.11	20.57	5.19	-	-	-
F. insignis	-	-	-	7.62	-	20.37	3.54	-	-	-	-
	-	-	-	5.14	-	11.65	2.13	-	-	-	-
F. mysorensis	-	-	5.54	4.57	9.05	1.25	3.87	10.26	11.44	1.54	-
	-	-	-	2.76	7.02	1.14	3.32	7.41	4.18	-	-
F. retusa	5.71	8.37	3.26	-	-	10.40	3.37	11.97	4.38	4.62	18.52
	18.44	38.46	23.57	-	19.23	22.16	12.81	28.89	23.58	20.31	39.77
F. tsiela	3.27	5.02	2.80	6.09	9.50	10.81	8.92	25.21	12.12	26.92	24.07
	11.06	14.42	23.92	35.13	21.93	20.17	24.90	32.60	22.40	62.50	39.77
Grewia tiliaefolia	-	7.95	30.94	25.91	28.96	-	-	-	-	-	-
	-	3.85	.25.22	24.16	20.18	-	-	-	-	-	-
Lantana camera	1.22	2.51	3.58	6.09	1.81	8.52	5.05	3.85	13.13	5.38	7.41
	-	-	-	-	-	-	-	-	-	-	-
Leea indica	-	2.93	2.80	7.62	9.50	11.43	5.05	-	0.67	-	-
	-	-	-	-	-	-	-	-	-	-	-

TABLE 4 (*contd.*)

*PERCENTAGE OF *M. VIRIDIS* AND *M. RUBRICAPILLA* FEEDING ON FRUITS/NECTAR

	1978							1979			
	Apr	May	Jun	Jul	Aug	Nov	Dec	Jan	Feb	Mar	Apr
Loranthus sp.	-	-	-	-	-	0.62	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Machilus macrantha	5.71	-	-	-	-	-	-	-	16.16	16.15	10.00
	-	-	-	-	-	-	-	-	-	-	-
Macaranga sp.	-	3.77	-	-	-	1.25	-	-	2.36	-	-
	-	-	-	-	-	-	-	-	-	-	-
Olea dioica	6.53	2.09	-	-	-	-	-	-	-	-	2.59
	7.37	2.93	-	-	-	-	-	-	-	-	-
Santalum album	7.37	2.93	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Scolopia crenata	5.71	-	-	-	-	-	-	-	-	-	3.33
	5.53	-	-	-	-	-	-	-	-	-	-
Solanum indicum	3.67	2.51	1.30	3.04	2.71	-	3.87	2.56	5.39	11.54	3.70
	-	-	-	-	-	-	-	-	-	-	-
Spathodea campanulata	-	-	1.30	1.83	0.09	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Syzygium cumini	3.67	10.46	-	-	-	-	-	-	-	-	-
	3.23	5.29	-	-	-	-	-	-	-	-	-
Viscum sp.	-	-	-	-	-	-	-	-	1.01	-	-
	-	-	-	-	-	-	-	-	-	-	-
Ziziphus sp.	2.04	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Total feeding on	67.34	61.51	61.29	70.39	68.86	74.65	71.99	77.34	75.25	66.15	69.62
plant materials	73.28	78.85	80.35	79.73	74.50	76.00	79.08	80.76	81.82	82.81	79.54

*Notes: Upper figures in each column are for *M. viridis* and lower for *M. rubricapilla*.
Percentage is calculated from the total number of birds observed feeding both on animal and plant materials.
Remaining percentage is formed by birds feeding on animal matter.



1. *Actinodaphne hookeri*, 2. *Ficus gibbosa*, 3. *F. retusa*, 4. *F. tsiela*, 5. *Grewia tiliaefolia*, 6. *Ficus mysorensis*, 7. *F. insignis*.

Fig. 3: Percent difference in common fruits consumed by a: *M. viridis*, b: *M. rubricapilla*

whereas, both feed almost equally on *F. infectoria*. Comparatively, *M. viridis* prefers receptacles of *F. mysorensis*. In addition to feeding together with *M. rubricapilla* on *Ficus* trees, *M. viridis* frequently feeds on the fruits of *Bischofia javanica*, *Leea indica*, *Lantana camara* and *Solanum indicum*.

During March, *F. retusa* and *F. tsiela* are the main trees on which both species feed, *M. rubricapilla* far more than *M. viridis*. In April, several more species start fruiting. *M. viridis* shows a greater preference for *Actinodaphne hookeri* which fruits from April to July. In addition to berries of shrubs, *M. viridis* feeds exclusively on *Machilus macrantha*. *F. gibbosa* and *F. tsiela* fruit during April, for whose receptacles *M. rubricapilla* always shows greater preference (Fig. 3a & b).

From May to August, *Grewia tiliaefolia*, *F. retusa* and *F. tsiela* are the main fruiting trees on which both *M. viridis* and *M. rubricapilla* feed. During this period, both barbets show a higher preference for *Grewia* than for other fruits, though as usual *Ficus* trees are also visited freely and *M. rubricapilla* feeds more on *Ficus* receptacles than *M. viridis*. In addition, *M. viridis* also feeds on the fruits of *Macaranga*, *Lantana*, *Solanum* and on nectar of *Erythrina*; rarely also on nectar of *Spathodea campanulata*. The only fruits on which *M. rubricapilla* feeds exclusively are of *Eucalyptus*. During May to August, young fruits of *Eucalyptus* are quite often eaten by *M. rubricapilla*, mainly in the morning hours. *M. viridis* does not feed on Eucalyptus fruits, probably because this plant is recently (about 20 years earlier) introduced in the area. *M. viridis* shows higher preference for the fruits of *Olea dioica*, *Scolopia crenata* and *Syzygium cumini*, which appear from April to May. Sandalwood drupes are exclusively eaten by *M. viridis* during April-May.

During November-December *M. viridis* shows a higher preference for the figs of *F. insignis*, whereas *M. rubricapilla* feeds more frequently on *F. gibbosa*, *F. retusa* and *F. tsiela*; both show almost equal preference for *F. infectoria*. Only *M. viridis* feeds on fruits of *Solanum*, *Lantana* and *Leea indica*, and nectar of *Bombax ceiba* and *Erythrina*. Very rarely, both feed on *Evodea lunuankenda*, *Loranthus* and *Viscum* berries.

Therefore, although both the species

overlap on certain fruiting trees, almost every month *M. viridis* feeds exclusively on certain other fruits (such as *Bridelia retusa, Careya arborea, Lantana camara, Leea indica*), thus reducing the extent of food competition.

Possible reasons for food preference

The primary reason for food preference in *M. viridis* and *M. rubricapilla* appears to be the size of the fruit. However, selection of food may also depend on various other factors such as colour, taste, nutritive value, and even on smell, as suggested by several workers. Figs of *F. tsiela*, *F. retusa*, and *F. gibbosa* are preferred by *M. rubricapilla* and those of *F. mysorensis* and *F. insignis* by *M. viridis*. The figs of the former group are about one-fourth the size of the latter two. *M. rubricapilla* shows less preference for the fruits of *A. hookeri*, *G. tiliaefolia*, *Olea dioica*, *Scolopia crenata* and *Syzygium cumini*, which are larger than its favourite figs. The frequency of feeding in relation to fruit size is shown in Table 5. *M. rubricapilla* shows markedly higher preference for smaller fruits, though *M. viridis* also feeds on them.

Low preference for larger fruits by *M. rubricapilla* can be correlated with its smaller beak. Correlation between the size of the food and beak has also been reported in the Galapagos ground finches by Lack (1971), and in British finches by Newton (1967). Vijayan (1975) also found that the whitebrowed bulbul (*Pycnonotus luteolus*) with its slightly larger beak prefers bigger sized fruits than the coexisting redvented bulbul (*P. cafer*).

Though not analysed statistically, *M. zeylanica* and *M. haemacephala* in Sanjay Gandhi National Park, Borivli, Mumbai (SGNP) and at Lowercamp, appeared to show remarkable food preference according to size; the former preferring figs of *F. bengalensis* and *F. mysorensis*, whereas the latter always congregated in greater numbers on *F. gibbosa*, *F. infectoria* and *F. religiosa*. *M. zeylanica* was often found sipping nectar on *Butea monosperma* at SGNP, but *M. haemacephala* was never seen doing so. At Ranikhet (Uttar Pradesh) *M. virens* was recorded gulping pear blossom (*Pyrus sinensis*) conveniently owing to its large beak.

TABLE 5
PERCENTAGE OF *M. VIRIDIS* AND *M. RUBRICAPILLA* FEEDING ON FRUITS OF DIFFERENT SIZE

	Average size of the fruit		
	<8 mm	8-16 mm	>16 mm
M. viridis (n = 2352)	37.45%	34.31%	28.24%
M. rubricapilla (n = 1485)	70.09%	19.90%	10.01%

Animal food of *M. viridis* and *M. rubricapilla*

Insects of different groups comprise the main animal food of *M. viridis* and *M. rubricapilla*. A month-wise record of animal food taken by these two species is shown in Tables 3 and 4 respectively. They usually hunt insects while following mixed hunting parties. However, during the breeding season both search for insects individually or in pairs. Quite often, both the barbet species were found capturing winged termites by short 'flycatching' sallies after light rain during March-April. These hunts normally take place in groups; one such group of 30 *M. rubricapilla* was recorded hunting winged termites for 30 minutes at Thanikuddy area. All the birds were perched on a *Terminalia paniculata* tree and caught the termites in the air one by one as they emerged from the ground. While the barbets were catching termites at about 16m height, swallows were also catching the termites much higher than the barbets, while red-whiskered bulbuls *Pycnonotus jocosus* were diving after them from bushes nearby.

During April-May the teak defoliator, *Hyblaea puera*, swarm on young teak leaves and both barbets congregate in large numbers to feed on these caterpillars along with other birds. Except for this caterpillar, no swarming of any particular species was noticed during the study period at Thekkady. A Phalangid species was

found swarming in hundreds on some shrubs and tree trunks throughout the year, but no bird was seen to feed on them.

Formation of Mixed Hunting Parties (MHP)

At Thekkady, the formation of large MHPs is a common avian activity. Generally bright hours of the day (Table 6) and comparatively open areas are selected for forming a MHP. In the non-breeding season, both *M. viridis* and *M. rubricapilla* commonly hunt with MHPs. A MHP sometimes follows a longer route, but normally limits itself to a circumference of *c.* 250 m or so. A 'wave of birds' as described by McClure (1972) was always noticed while observing the MHP. The difference between the flocks of insectivores and those assembled in a fruiting tree is that the insectivores' 'wave' moves through the forest, while the frugivores confine themselves to a specific tree (McClure, 1972).

TABLE 6
PERCENTAGE OF *M. VIRIDIS* AND *M. RUBRICAPILLA* FEEDING AT DIFFERENT HOURS OF THE DAY WITH MIXED HUNTING PARTY AVERAGE OF 11 MONTHS APRIL 1978 TO APRIL 1979

	6 to 10 hr.	10 to 14 hr.	14 to 18 hr.	Total No. of birds observed
M. viridis	09.75	75.00	15.25	682*/994**
M. rubricapilla	15.00	78.15	06.84	205*/404**

* Number of birds seen hunting with MHP

** Total number of birds seen feeding on animal mater

Position of barbets in MHP

Normally, 10-12 bird species comprise a single MHP, but sometimes as many as 25 species were recorded, the commonest and perhaps the 'nucleus' of the party being drongos. The common species forming a MHP were usually the racket-tailed drongo (*Dicrurus paradiseus*), grey drongo (*D. leucophaeus*), bronzed drongo (*D. aeneus*), goldenbacked woodpecker (*Dinopium benghalense*), goldenbacked threetoed woodpecker (*D. javanense*), common and southern tree pies (*Dendrocitta vagabunda, D. leucogastra*), common woodshrike (*Tephrodornis virgatus*), jungle and hill mynas (*Acridotheris fuscus, Gracula religiosa)* minivets (*Pericrocotus flammeus, P. cinnamomeus*), tits (*Parus major, P. xanthogenys*) velvet-fronted nuthach (*Sitta frontalis*) and various species of flycatchers. Barbets are opportunist members of the party, joining a passing MHP and hunting actively with the rest. *M. viridis* being far more active than *M. rubricapilla* exploits the maximum feeding zone.

While 'flowing' with the wave, *M. viridis* makes short sallies, glides down after insects or even lands on the ground, whereas *M. rubricapilla* never descends below the secondary level. However, both peck on dry and dead tree trunks like woodpeckers, and at times on dry leaves, and pick up caterpillars. Intraspecific aggression between *M. viridis* and *M. rubricapilla* was not as common in a MHP as noted on fruit trees. This could be due to the marked difference in their feeding zones and larger feeding areas. On a fruit tree, especially when fruit is scarce, there is more rivalry and aggression — fight and chase — while in a MHP the food resource is always scattered. However, intraspecific aggression among *M. viridis* itself is not uncommon.

Aggression among other groups of birds in a MHP is also not as common as among a feeding flock of frugivores in a fruiting tree. However, racket-tailed drongos always try to dominate and chase other birds, even snatching morsels from them, as I have witnessed on several occasions.

COMPETITION FOR FOOD AND COEXISTENCE

From the foregoing account, it appears that *M. viridis* and *M. rubricapilla* do not compete severely for food. However, they do overlap on certain fruiting trees or when hunting in a mixed hunting party of insectivores. As discussed below,

the food competition is further reduced owing to their different feeding behaviour and overall dimensions.

Feeding habitat

Utilisation of different parts of the vegetation differs greatly between *M. viridis* and *M. rubricapilla*. The feeding zone is clearly distinguishable when both feed in a single microhabitat. During the study period, whether feeding on fruit or hunting insects, individually or with MHP, 82% *M. rubricapilla* were recorded feeding on the tertiary level, whereas only 51% *M. viridis* fed at that level. *M. rubricapilla* was seldom recorded descending below the secondary level (Table 7), while *M. viridis* frequently fed at the primary level or at times even on the ground, *M. rubricapilla* never does so.

TABLE 7
PERCENTAGE OF *M. VIRIDIS* AND *M. RUBRICAPILLA* FEEDING AT DIFFERENT LEVELS

	M. viridis (n = 3346)	*M. rubricapilla* (n = 1889)
Ground	0.15%	-
Primary level, 1 to 4 m	18.42%	-
Secondary level, 4 to 8m	29.93%	17.06%
Tertiary level, above 8m	51.50%	82.94%

Ecological isolation by feeding heights has been reported in English titmice *Parus major* by Hartley (1953) and Gibb (1954). Vijayan (1975) suggested that the difference in the feeding zone is distinguishable in coexisting *Pycnonotus cafer* and *P. luteolus* at Point Calimere (Tamil Nadu) and plays a major role in isolating them ecologically.

At Lowercamp, *M. zeylanica*, *M. viridis* and *M. haemacephala* were sometimes observed hunting together with a MHP. On those occasions, the feeding zones of the three species were always markedly different; *M. zeylanica* hunted at the topmost level, *M. haemacephala* mostly at secondary level, whereas *M. viridis* fed at the primary and secondary levels.

Method of feeding

The feeding methods of *M. viridis* and *M. rubricapilla* differ considerably, especially on larger fruits like the receptacles of *Ficus mysorensis* and *F. bengalensis* and other similar sized fruits. While *M. viridis* swallows the entire fruit, *M. rubricapilla* feeds by pecking and eating it bit by bit. The difference in feeding method is obviously due to the differences in their beak size. While *M. viridis* swallows larger fruits easily, *M. rubricapilla* cannot do so, and has to spend more time and energy on the same fruit. At Lowercamp, occasionally *M. zeylanica*, *M. viridis*, *M. haemacephala* and sometimes *M. rubricapilla*, were recorded feeding together on *F. bengalensis* and *F. mysorensis*. The feeding method of the two larger and two smaller 'pairs' was noted to be different: *M. zeylanica* and *M. viridis* with larger beaks normally swallowed the entire receptacles, whereas the other two (with almost equal beak size) fed by pecking at them bit by bit. Such a difference in method of feeding was recorded in unequal sized congeneric sympatric *M. asiatica* and *M. haemacephala*, and *M. lineata* and *M. haemacephala* respectively in Calcutta Botanical Garden and in Valmiki Tiger Reserve (Bihar).

Even while hunting insects individually or with MHP, *M. viridis* frequently catches cicadas, butterflies and such larger insects, whereas *M. rubricapilla* restricts itself to ants, small flies and termites.

Feeding cycle

Barbets are voracious feeders and can be seen feeding throughout the day. However, intensity of feeding activity varies during different hours of the day (Table 8). Both *M. viridis* and *M. rubricapilla* show maximum feeding activity during morning hours. *M. viridis* is comparatively less active around noon and more active in the afternoon. The difference in feeding cycle appears to be due to the differences in their roosting hours (Yahya 1987). On an

average, *M. rubricapilla* roosts one hour longer than *M. viridis*, and hence is probably more active in the noon hours also, while *M. viridis* takes rest. After some rest *M. viridis* becomes more active and hence spends more time in feeding, while in the later afternoon *M. rubricapilla* spends more time in preparing to roost.

TABLE 8
PERCENTAGE OF *M. VIRIDIS* AND *M. RUBRICAPILLA* FEEDING AT DIFFERENT HOURS OF THE DAY ON DIFFERENT FRUIT TREES

	6 to 10 hrs	10 to 14 hrs	14 to 18 hrs
M. viridis (n = 2325)	47.40	22.50	30.09
M. rubricapilla (n = 1485)	48.00	28.33	23.67

Similar results were obtained while observing *M. zeylanica* and *M. haemacephala* at Sanjay Gandhi National Park. *M. zeylanica* showed less feeding activity during noon hours whereas *M. haemacephala* was quite active during that period. *M. haemacephala* also roosts almost one hour longer than *M. zeylanica* (Yahya 1987). Skutch (1944) also found the prong-billed barbet most active in the morning hours and least active at noon, when it rested for 1 to 2 hours.

Aggression at feeding sites

Intraspecific aggression is much more pronounced in *M. viridis* than in *M. rubricapilla.* The former is far more aggressive towards other species of birds as well. While feeding with frugivorous flocks, *M. viridis* chases almost all birds except the koel *Eudynamys scolopacea.* The koel was found to be the most dominant species and no other bird dared to fight it back. Intraspecific aggression at feeding sites might play some role in isolating two congeneric sympatric species and thus help in successful coexistence. Grubh (1979) concludes that intraspecific aggression at food plays an important role in successful coexistence of the Eurasian griffon *Gyps fulvus,* whitebacked vulture *G. bengalensis* and longbilled vulture *G. indicus* in Gir Forest: while the whitebacked is comparatively peaceful at feeding sites, the other two spend considerable time quarrelling with their own kind, thereby indirectly permitting the weaker whitebacked to feed.

Morphological adaptations for feeding

In physical dimensions *M. viridis* and *M. rubricapilla* are different. The larger beak of *viridis* enables it to swallow larger fruits and insects, which *rubricapilla* cannot do. This could help them in reducing food competition and successful coexistence. Zacharias (1978) states that owing to the difference in overall size, the larger jungle babbler *Turdoides striatus* mostly feeds on larger insects while hunting together with whiteheaded babblers *T. affinis.* Another point which supports the view that the overall size difference in barbets may play an important role in their successful coexistence is the common occurrence side by side of two species of different sizes. During my study I found *M. viridis* and *M. rubricapilla* occurring together at Thekkady; *M. zeylanica* and *M. haemacephala* coexisting at Sanjay Gandhi National Park, Hazaribagh National Park and at the Betla Tiger Reserve; *M. lineata* and *M. haemacephala* coexisting in Valmiki Tiger Reserve and Corbett National Park, and *M. asiatica* and *M. haemacephala* in Calcutta City. All these coexisting congeneric species have the same remarkable differences in size. Hinde (1959) suggested that the morphological differences between coexisting species are not merely adapted to feeding methods, but largely determine them. The degree of dominance while feeding may also vary according to the body size as reported by Grubh (1979) among different species of griffon vultures – the largest (Eurasian griffon) was found to be the most dominant and the smallest (whitebacked) the least.

CONCLUSION

Though fruits of different species of plants constitute the main food of barbets, both *M. viridis* and *M. rubricapilla* feed on insects to

a considerable extent. The former consumes about 30% animal matter, whereas the latter consumes about 20%. *M. viridis* consumes more insects during the breeding season than *M. rubricapilla*. Only *M. viridis* sips nectar from flowers. Both species often hunt together with mixed hunting parties of insectivores; *M. viridis* always joins the party in larger numbers and for longer periods. During March-April, after light showers, both the species hunt winged termites in groups; sometimes this single-species group may consist of as many as 30 individuals.

Food competition between the coexisting *M. viridis* and *M. rubricapilla* is not severe, for they normally procure food from different feeding zones. Intraspecific aggression among *M. viridis* is markedly more while feeding either on a fruit tree or with a mixed hunting party of insectivores which reduces its competition for food with *M. rubricapilla* to some extent. Another factor responsible for ecological isolation in feeding behaviour is the varying heights from which they exploit food: while *M. viridis* feeds at primary, secondary and tertiary levels, and at times lands even on the ground, *M. rubricapilla* restricts itself to the secondary and tertiary levels.

The study also supports Huxley's (1942) postulation that "big size difference between congeneric species of birds are means of ecological isolation". Based on the data collected in the present study, it could be added that since food is the primary requirement of an animal, for the successful coexistence of two closely related species in a single habitat, divergent morphological adaptations in relation to feeding habits are an outcome of the process of natural selection.

Barbets are economically important and play a significant role in controlling various harmful insects, in cross-pollination and seed dispersal of trees. Though they are presently common in many places, their conservation priorities should be anticipated by wildlife biologists and managers to maintain sustainable populations of different species.

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NEW DESCRIPTIONS

SPINY EELS OF THE GENUS *MACROGNATHUS* LACEPEDE FROM MANIPUR, WITH DESCRIPTION OF A NEW SPECIES[1]

L. Arunkumar and H. Tombi Singh[2]

(*With four text-figures*)

Key words: *Macrognathus morehensis* sp. nov., Yu drainage system, Manipur.

The paper gives a systematic account of two species of *Macrognathus,* hitherto known from Manipur, *viz. M. aral* (Bloch & Schneider) and *M. pancalus* Hamilton-Buchanan, which are distributed in the Barak drainage system and in the hill streams of Manipur respectively. A new species *M. morehensis* occurring in Manipur has been described here. It is found in the southeastern corner of this state and the adjoining areas of Myanmar, drained by the Yu drainage system, known as the Chindwin of Meaner. The diagnostic feature of *M. morehensis* is the combination of the following distinctive characters: 11 to 16 dorsal spines, 20 to 25 broad black transverse bars, 12 to 14 black spots that form imperfect ocelli at the base of dorsal fin rays, 6 black oval spots at the base of dorsal spines, 10 to 13 black spots at the base of anal fin rays, 5 to 7 oblique striations of black dots arranged in longitudinal parallel rows at the dorsal and anal fin rays, 7 to 10 black lines of striations formed by the dots at the caudal fin, a single ocellus at base of caudal fin, 8 to 11 rostral tooth-plates, and 76 vertebrae.

Introduction

Manipur is an isolated hill state in the northeast corner of India having three drainage systems: the Barak, Manipur, and Yu drainage systems draining the western, central and eastern water bodies respectively (Fig. 4). The Barak drainage system is connected with the Barak-Brahmaputra river system of India, whereas the Manipur drainage and the Yu drainage systems are connected with the Chindwin river system of Myanmar.

Hora (1921) described a new species of spiny eel, *Mastacembelus manipurensis* from Khurda (Khordak) stream of Manipur and *Rhynchobdella dhanashorii* from Dhanashori stream, about a mile from Dimapur, Assam. Menon (1954), while reporting on the fishes known from Manipur, listed two spiny eels, *viz. M. armatus* and *M. manipurensis*. Later, Menon (1974) considered *M. manipurensis* and *R. dhanashorii* as synonyms of *M. armatus* and *Macrognathus aculeatus* respectively. Presently, three species, *viz. M. aral* (Bloch & Schneider), *M. guentheri* (Day) and *M. pancalus* Hamilton-Buchanan have been reported from Indian waters (Talwar and Jhingran, 1991).

No further report is available on the spiny eels of the genus *Macrognathus* of Manipur. Recently, several specimens of *Macrognathus* were obtained from the Lokchao river and the Maklang river of the Yu drainage system of this state near Moreh, which is known as Chindwin of Meaner. From this collection, a new species, *Macrognathus morehensis*, is described here.

Material and Methods

Fishes were collected using different types of nets, grooping, dewatering of shallow water pockets and with the help of local fishermen. Some fishes were also purchased from Moreh Bazar, Chandel dist., Manipur, near the Indo-Myanmar border. In the field, their local names and fresh colours were noted.The fishes were

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then preserved in 10% formaline and brought to the Fishery Laboratory of Manipur University.

The fishes were identified with reference to Day (1889), Hamilton-Buchanan (1822), Roberts (1980, 1986) and, Talwar and Jhingran (1991). The specimens were deposited in the Manipur University Museum of Fishes (MUMF). Registration numbers are given below.

Results

Macrognathus aral (Bloch & Schneider) (Fig. 1)

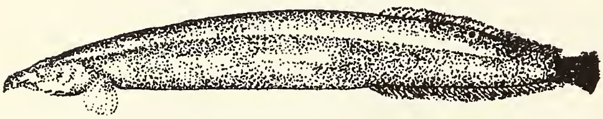

Fig. 1: *Macrognathus aral* (Bloch and Schneider)

Rhynchobdella dhanashorii Hora, 1921. *Rec. Indian Mus., XXII*: 205, Pl. IX fig. 2 (sp. nov.).

Macrognathus aral Roberts, 1980. *Copeia, 3*: 385-391, fig. 1 2b (Revision).

Macrognathus aral Talwar & Jhingran, 1991 *Inland Fish. India & Adjacent Countries, 2*: 1026 (Distribution extended).

Manipuri name: *Ngaril/Jirigi ngaril pokchaobi/Ngaril yangmitpanbi.*

Material examined: 3 exs. Uncat. MUMF. 1 from Jiri River; 120 mm total length; 7.viii.1995, 2 ex. Makru stream; 124 to 135 mm total length; 2.ix.1985, coll. M.G. Sharma, 1 ex. MUMF 201/1A, Jiri River, 205 mm total length, 16.x.1992, coll. L.A.

Distribution: Manipur: Barak drainage system.

Remarks: Formerly reported as *M. aculeatus* and distributed strictly in the western sides of this state, drained by the Barak drainage system of the Brahmaputra system in India. It is easily distinguished from *M. aculeatus* by the lack of 14 to 17 oblique dark bars on the body and smaller number of rostral tooth-plates (18 to 21 vs. 38 to 55). Roberts (1980) stated that *M. aculeatus* was known from the southern half of the Malay Peninsula: several of the principal rivers of Sumatra; the Kapaus river of Borneo and northern Java as far east as the Brantas river. The specimens (*M. aral*) from the Barak drainage of Manipur are similar to *M. siamensis* (Roberts 1980) in the presence of ocelli at the base of dorsal fin rays, but can be easily distinguished by the lack of ocelli at caudal fin, smaller number of rostral tooth-plates (18 to 21 vs. 7 to 14), and total number of vertebrae (71 vs. 75).

Macrognathus pancalus Hamilton-Buchanan (Fig. 2)

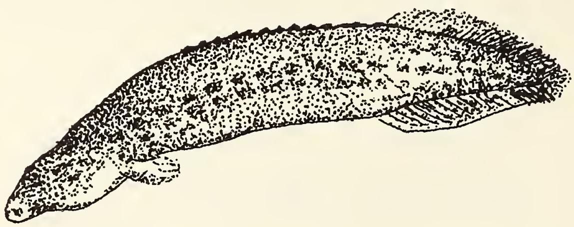

Fig. 2: *Macrognathus pancalius* Hamilton-Buchanan

Macrognathus pancalus Hamilton-Buchanan, 1822. *Fish Ganges*, 30, 364, pl. XXII, fig. 7.

Mastacembelus pancalus Sufi, 1956 *Bull. Raffles Mus., 27*: 93-146 (Revision).

Macrognathus pancalus Talwar & Jhingran, 1991 *Inland Fish. India & Adjacent Countries*, 2: 1027-1028, Fig. 292.

Manipuri name: *Ngaril/Ching-ngaril-macha.*

Material examined: 3 exs. MUMF 202/3A, 1 ex. Jiri River; 111 mm total length; 13.xii.1990, 1 ex. Litan stream at the root of Thoubal river; 132 mm total length; 15.xi.1991 and 1 ex. Maklang river; 124 mm total length; 8.xii.1992, coll. L.A.

Distribution: Manipur: Hill streams and

rivers of the Barak drainage, the upper and lower regions of Manipur drainage and the Yu drainage system.

Remarks: It is the smallest among spiny eels and mainly found in hill streams. A distinct streak of longitudinal spots runs along the lateral line from the eye to the base of caudal fin in the present specimen, with 65 to 66 vertebrae. Roberts (1986) mentioned that it belongs to the second group of *Macrognathus* which lack rostral tooth-plates.

Macrognathus morehensis sp. nov.
(Fig. 3)

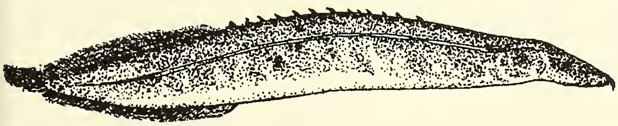

Fig. 3: *Macrognathus morehensis* sp. nov., MUMF 203/8A Paratype, 147 mm TL, Manipur: Yu drainage system.

Holotype: MUMF 203/1A, from Maklang river near Moreh Bazar, Chandel district, 155 mm total length 17.x.1992. Coll. L.A.

Paratypes: MUMF 203/8A, 3, from Lokchao river near Moreh Bazar. 5 from Moreh Bazar; near Indo-Myanmar border, 80 to 147 mm total length. 21.x.1992. Coll. L.A.

Manipuri name: *Ngaril/Ngamoi-tup/ Ngamu-tup/Tou-ngaril*

Diagnosis: A *Macrognathus* has the distinctive combination of the following characters: (i) 11 to 16 dorsal fin spines, (ii) 20 to 25 black broad transverse bars on the body, (iii) 8 to 11 rostral tooth-plates, (iv) 12 to 14 black spots that are imperfect ocelli at the base of dorsal fin rays, (v) 10 to 13 distinct black spots at the base of anal fin rays, (vi) 6 black oval spots at the base of dorsal spines, (vii) 5 to 7 oblique striations of black dots arranged in parallel longitudinal rows at the dorsal and anal fin rays, (viii) 7 to 10 black lines of striations formed by dots at the caudal fin, (ix) a single ocellus at the base of caudal fin and (x) 76 vertebrae.

Description: Br. 3-5, D. 11-16/39-51, P. 15-20, A. 3/40-54, C. 11-14. Body slightly compressed. Rostrum slightly rounded. Pre-orbital and pre-opercular spines absent. Head long and pointed. Mouth inferior, cleft of mouth narrow. Ventral side of snout transversely striated by 2 to 4 black bars. Eyes not visible from ventral side and covered by a thin membrane. Eye diameter more or less same as the interorbital distance. Lips thin. No gill rakers. Caudal fin distinctly separated from the dorsal and anal fins. Scales are minute. The third anal spine is very near the origin of anal soft fin rays and difficult to identify, since it is buried inside the skin.

Proportional measurements of holotype and paratypes (the latter in parenthesis): Depth of body 10.97 (11.11-12.93), height of head at eye 4.51 (4.08-6.25), height of head at occiput 6.45 (6.25-7.69), length of head at occiput 12.90 (11.11-15.47), length of head at the end of lateral operculum 17.42 (17.36-22.22) and length of caudal fin 7.09 (6.94-9.52) in the percentage of total length respectively.

Depth of body 11.80 (11.94-13.79), height of head at eye 4.86 (4.41-6.84), height of head at occiput 6.94 (6.72-8.33), length of head at the end of lateral operculum 18.76 (18.65-24.33), length of pectoral fin 6.94 (7.14-8.62), predorsal length at the origin of dorsal fin spine of 43.85 (43.29-46.72), and predorsal length at the origin of dorsal fin soft rays 63.29 (62.11-69.93) in the percentage of standard length respectively.

Diameter of eye 33.33 (33.33-35.59), interorbital distance 33.33 (33.33-35.95) and width of mouth 22.22 (20.00-25.00) in percentage of length of snout respectively.

Colour: Body light yellowish to ashy. In young stages (81-120 mm total length), the dorsal fin soft rays, anal fin soft rays and caudal

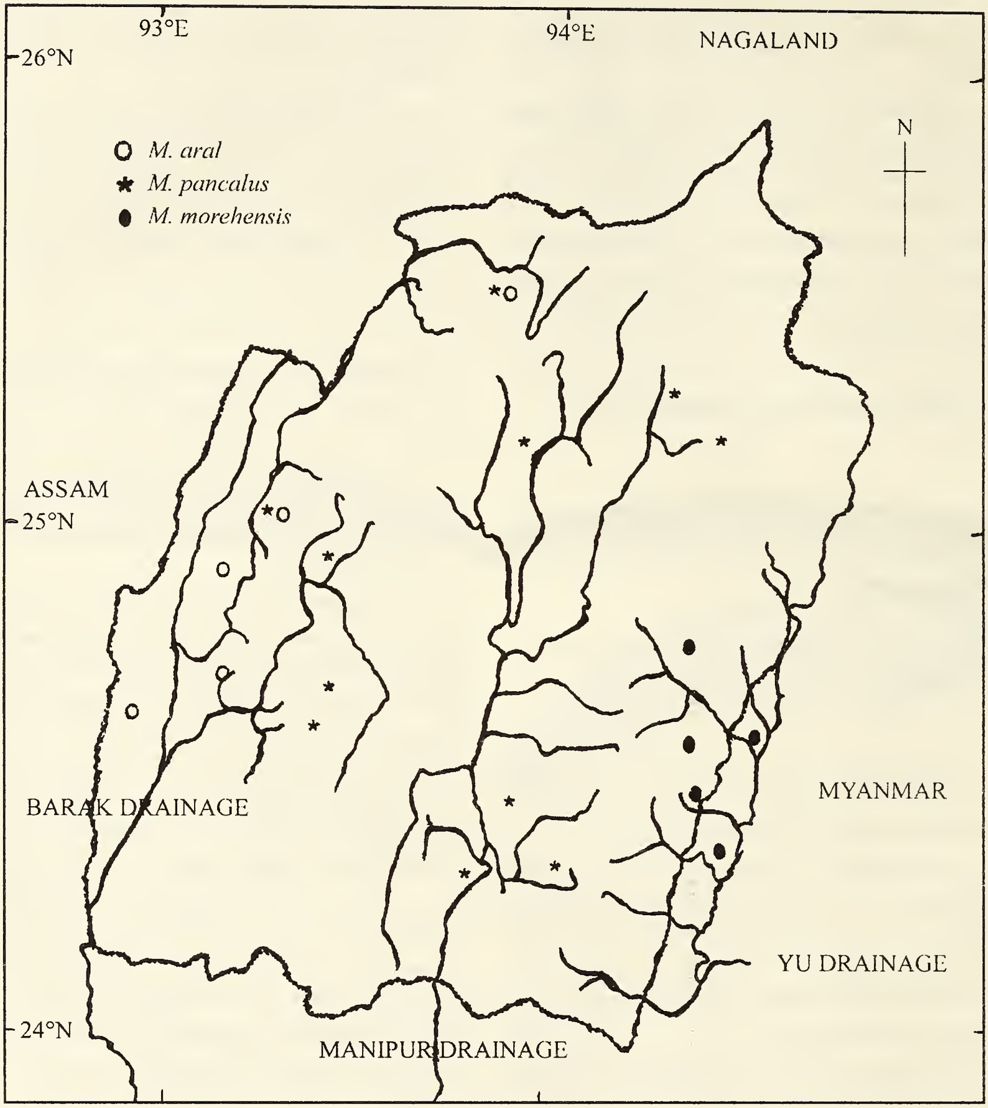

Fig. 4: Map of Manipur showing distribution of *Macrognathus*

fins are distinctly red with black striations and pin dotted transverse bars along their entire length. Abdomen yellowish white.

Habitats: *M. morehensis* has a habit of actively burrowing in the swampy and vegetated stream bed. The inhabitants of Kwatha village near Moreh, of the Indo-Myanmar border call it '*Tou-ngaril*', according to the habitat of the fish. The fish hides under pebbles, stones, gravel, sandy beds of clear torrential stream. It makes small pits and holes in the swampy and vegetated beds of stagnant streams and waterbodies. The fish is associated with *Amblypharyngodon mola*, *Aspidoparia morar*, *Badis badis*, *Chanda nama*, *Chela laubuca*, *Colisa fasciata*, *Danio aequipinnatus*, *Esomus dancricus*, *Garra gravelyi*,

G. lissorhynchus, *G. rupecola*, *Glyptothorax pectinopterus*, *G. platypogonoides*, *G. trilineatus*, *Mystus bleekeri*, *M. cavasius*, *Nemacheilus vinciguerrae* and *Parluciosoma daniconius*. Its distribution extends upto Tumu of Myanmar.

Remarks: *M. morehensis* is easily distinguished from *M. guentheri* (Day) and *M. pancalus* Hamilton-Buchanan by the presence of rostral tooth-plates. It is also easily distinguished from *M. aral* (Bloch & Schneider) by the presence of less rostral tooth-plates (8-11 vs. 14-28), dorsal fin spines (11-16 vs. 16-23), total number of vertebrae (76 vs. 71), coloration (indistinct i.e. imperfect ocelli vs. distinct ocelli at base of the dorsal soft fin rays, and an ocellus at base of caudal fin vs. absent) and specific distribution, *viz.* Yu drainage system vs. Barak drainage system of Manipur.

Etymology: The specific name is derived from Moreh, the type locality of the fish.

Discussion: Roberts (1980, 1986) stated that *M. aculeatus* was known strictly from the southern half of the Malay Peninsula. He synonymised and referred all the formerly well known species of *M. aculeatus* which are distributed in India to *M. aral*. *M. aculeatus* had not been found in Myanmar or in the Indian subcontinent, but was found in Thailand at Surat Thani, Chiao Lam and the Tapi River basin.

M. morehensis can be easily differentiated from *M. caudiocellatus*, *M. circumcinctus*, *M. semiocellatus* and *M. zebrinus* by the absence of preopercular and preorbital spines, and presence of rostral tooth-plates.

M. morehensis differs from *M. aral* in having a smaller number of rostral tooth-plates (8-11 vs. 14-28), fewer dorsal fin spines (11-16 vs. 16-23), more vertebrae (76 vs 71) and pattern of bands (20 to 25 transverse dark bars vs. 2 pale longitudinal stripes along its entire length).

M. morehensis differs from *M. aculeatus* in having fewer rostral tooth-plates (8-11 vs. 29-55) and numbers of oblique transverse bars on the body (20-25 vs. 14-17).

M. morehensis differs from *M. meklongensis* in having a smaller number of dorsal fin rays (39-51 vs. 50-54), pectoral fin rays (15-20 vs. 22-23), caudal fin rays (11-14 vs. 16-19), coloration of black spots at dorsal fin base (12-14 distinct large spots which are imperfect ocelli vs. no ocelli or 10-12 faint small ocelli), rim of anterior nostril with finger-like projections (absent vs. 6) and transverse bars on the body (20-25 vs. absence of transverse bars).

M. morehensis differs from *M. siamensis* in the presence of fine dark striations in the caudal fin (7-10 fine black striations formed by dots vs. absence of striations), ocelli in the dorsal fin base (12-14 black spots which are imperfect ocelli vs. with series of large and distinct form of ocelli), fine oblique striations in the dorsal soft fin-rays (5-7 vs. absent) and distribution (Manipur vs. Thailand and Kampuchea).

M. morehensis has a restricted distribution in Moreh, near the Indo-Myanmar border, Chandel Dist., Manipur at lower portion of Lokchao river, Pumpum stream of Kwatha, Lairok Maru, lower portion of Maklang river, which belong to the Yu drainage system of Manipur, extend to Myanmar and join the Chindwin river. The fish was also collected from the adjoining areas of Manipur-Myanmar border of the Yu river system, which is known as the Chindwin of Meaner.

According to Kottelat (1989) and Zakaria-Ismail (1994), *M. aral, M. caudiocellatus* and *M. zebrinus* are the Salween elements of fishes. Kottelat (loc. cit.) described *M. aculeatus* as the Malay peninsular element of fish and *M. circumcinctus*, *M. meklongensis*, *M. semiocellatus* and *M. siamensis* as the Thailand elements of fishes. According to Zakaria-Ismail (loc. cit.) *M. aculeatus*, *M. caudiocellatus*, *M. circumcinctus*, *M. meklongensis*, *M. semiocellatus* and *M. siamensis* belong to the Indo-Chinese elements of fishes. *M. pancalus* is the true Indian element of fish. Hence *M. morehensis* is a distinct species with

meristic, morphometry, anatomy (vertebrae), colour pattern and specific distributional areas, i.e. the Chindwin of Meaner as the defining features.

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THREE NEW GENERA OF WHITEFLIES *MOHANASUNDARAMIELLA*, *SHANTHINIAE* AND *VASANTHARAJIELLA* (ALEYRODIDAE : HOMOPTERA) FROM INDIA[1]

P. Manidurai Manoharan David[2]

(*With three text-figures*)

Key words : Whiteflies, Aleyrodidae, Homoptera, *Mohanasundaramiella*, *Shanthiniae*, *Vasantharajiella*

In a survey conducted in the southern districts of Tamil Nadu and the adjoining forests of Kerala during 1991-1994, 84 species of aleyrodids under 34 genera were collected and studied. Of the 34 genera three, viz., *Mohanasundaramiella*, *Shanthiniae* and *Vasantharajiella* were found to be new and are described and illustrated.

Genus ***Mohanasundaramiella*** gen. nov.

Type-species: *Mohanasundaramiella rubiae* sp. nov.

Pupal case oval in outline, pale with no wax secretion; margin lobulate to serratulate; marginal setae present; tracheal pores and combs absent; submargin characteristically separated from dorsal disc by a well defined furrow; submarginal transverse ridges and furrows conspicuous; subdorsal fold-like suture extending between meso-metathoracic suture and third-fourth abdominal suture; submarginal setae present; cephalic, mesothoracic, metathoracic, first abdominal, eighth abdominal and caudal setae present; first abdominal setae located laterad of subdorsal fold-like suture. Vasiform orifice subcordate, operculum filling orifice, lingula tip exposed but included. Caudal furrow and ridges absent. Tracheal folds discernible.

Diagnosis. This genus is strikingly different from the known genera of Aleyrodini in having a well defined submarginal furrow that distinguishes submargin from dorsal disc. It resembles some species of *Crenidorsum* Russell in the furrow in inner subdorsal area of cephalothorax and abdomen, but differs from them in the presence of first abdominal setae and conspicuous submargin. Other distinguishing characters include presence of fewer than 19-21 pairs of dorsal setae that separate it from *Aleuromarginatus* Corbett, presence of first abdominal setae on subdorsum that are absent in *Aleyrodes* Latreille, presence of submedian meso- and metathoracic setae that are lacking in *Aleurocybotus* Quaintance & Baker, oval shape of pupal case that is typically elongate, parallel-sided and slightly square anteriorly and posteriorly in *Aleurotulus* Quaintance & Baker, and presence of minute submarginal setae that do not occur in *Aleurotrachelus* Quaintance & Baker.

Etymology: This genus is named in honour of Dr. M. Mohanasundaram, Professor of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, the renowned acarologist, who taught the author the science of taxonomy, and suggested this study.

Mohanasundaramiella rubiae gen. et sp. nov. (Fig. 1)

Pupal case: Oval in shape. 1.03-1.05 mm long and 0.87-0.89 mm wide, widest across abdominal segment III. Pale white with no wax secretion. Living on either surface of leaves.

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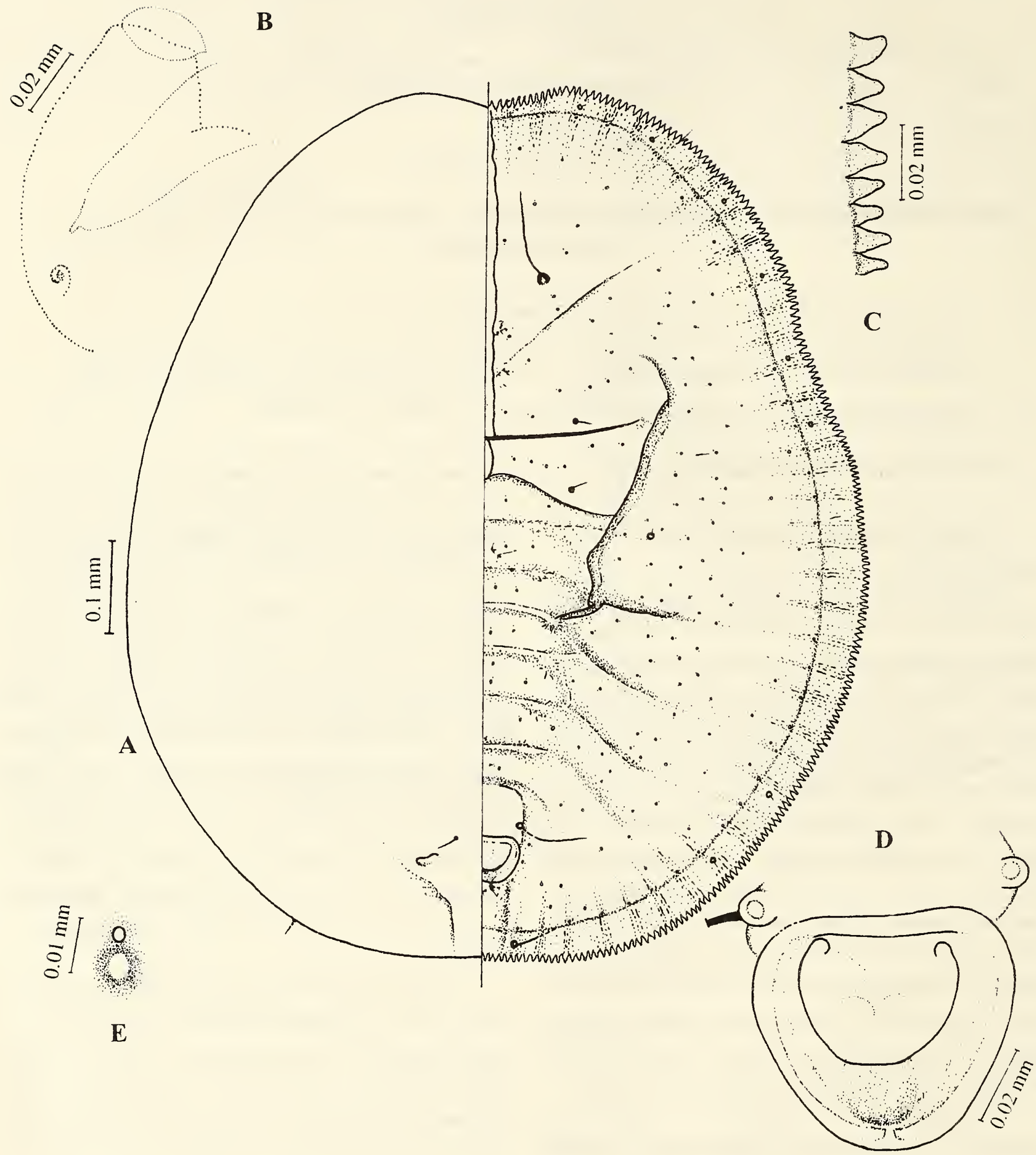

Fig. 1: *Mohanasundaramiella rubiae* gen. et sp. nov. : A. pupal case; B. prothoracic leg and antenna; C. margin; D. vasiform orifice; E. disc pore and porette

Margin: Lobulate to serratulate, about 14 teeth occupying 0.1 mm length of margin; teeth each longer than wide; margin slightly indented at cephalic and caudal ends medially and at thoracic tracheal pore areas. Tracheal pores and combs wanting. Anterior marginal setae 18.6 µm long, posterior marginal setae 38.0 µm long.

Dorsum: Dorsal disc separated from submargin by a distinct furrow. Submargin rather uniformly wide. Well defined transverse ridges

and furrows running mesad from margin to outer subdorsum; adjoining 2-3 furrows more sclerotized, alternating every 3-4 less prominent ridges and furrows. Minute submarginal setae in 8 pairs, 6 on cephalothorax and 2 on abdomen, 6.2-12.4 μm long. Dorsal disc with numerous disc pores and porettes, one row in submarginal fold, one each at the darker transverse furrows. Transverse moulting suture reaching margin, curved caudad from its midpoint, terminating slightly anterior to the first-second abdominal suture at the longitudinal subdorsal fold-like suture which characteristically extends between meso-metathoracic suture and third-fourth abdominal suture. Meso-metathoracic suture much pronounced. Abdominal segmentation distinct. Abdominal segments IV-VI with a weak rachis, their sutures running lateral into subdorsum. Median length of abdominal segment VII slightly shorter than that of VI. Submedian cephalic setae long, tapered with a prominent base, 86.8 μm long. Two pairs of submedian thoracic setae present: one pair on mesothorax 18.6 μm long, the other on metathorax 34.1 μm long. First abdominal setae transpositioned on subdorsum laterad of longitudinal fold-like suture, 6.2 μm long. Eighth abdominal setae 65.1 μm to at least 114.7 μm long, their bases anterocephalad of vasiform orifice. Caudal setae 28.0-74.4 μm long, located on submargin. Submedian abdominal depressions weak.

Vasiform orifice subcordate with a broader rim, 46.5 μm long, 62.0 μm wide, posterior margin notched inside. Operculum of identical shape, filling three-fourths of orifice, 34.1 μm long and 46.5 μm wide. Lingula tip setose, exposed but included. Caudal furrow and caudal ridges absent.

Venter: Thoracic tracheal folds faint, caudal fold distinct. Anterior thoracic and posterior abdominal spiracles evident. Adhesive sacs present. Antennae reaching anterior thoracic spiracles, their tips with a finger-like projection. Ventral abdominal setae 37.2 μm long.

Host: *Morinda* sp. (Rubiaceae)

Holotype: One pupal case mounted on slide, on *Morinda* sp., INDIA: Kerala: Walayar forest, 24.ix.1992, coll. M. Mohanasundaram (No.58 A.1.).

Paratypes: Six pupal cases on slides, same data as holotype.

Etymology: Species name derived from Rubiaceae, the host plant family.

Remarks. Two out of the seven pupal cases are parasitised.

Genus ***Shanthiniae*** gen. nov.

Type-species: *Shanthiniae sheryli* sp. nov.

Pupal case rather uniquely polyhedral in outline with lateral evaginations at six places on either side; margin very finely crenulate and crenate-looking, margin at pore area cleft; marginal setae present; thoracic tracheal pores well defined, inset with a single not very conspicuous tooth; dorsum ornamental with spots, reticulations; transverse moulting suture reaching margin; bases of cephalic, first abdominal and eighth abdominal setae distinct, caudal setae not discernible; abdominal segments VI and VII equally long, porettes with typically sclerotized rims; vasiform orifice cordate, with posterior margin toothed, operculum filling the orifice, lingula concealed; caudal furrow and ridges distinct; thoracic and caudal tracheal folds defined.

Diagnosis: Pupal case outline of this genus is extraordinarily unique in being a 12-sided polyhedron with six corners on either side. This shape is not seen in any other whitefly species or genera of the world. However, *Shanthiniae* is related to *Dialeurodes* Cockerell, *Dialeurolonga* Dozier, and *Dialeuronomanda* Quaintance & Baker in the distinct structure of thoracic tracheal pore with tooth and in the presence of a comb of teeth in the inner margin of vasiform orifice, especially posteriorly. It shows affinity to *Dialeurolonga* in lacking subdorsal or

submarginal row of setae but can be distinguished by the absence of small papillae in a row on the submarginal area. Its abdominal segments I-IV are subequal in length, similar to those in *Dialeurodes*, but are distinctive in the absence of a row of subdorsal setae. In both, *Shanthiniae* and *Dialeuronomada*, medium length of abdominal segment VII is shorter than that of VIII. Presence of a row of 12 marginal setae and a peripheral row of characteristic papillae on the submarginal area readily separate the latter from the former. The new genus differs from all the above three genera in the characteristic sclerotic pattern on the dorsum, in the transverse moulting suture typically reaching margin, in the location of vasiform orifice not greater than its length from posterior body margin, and in the absence of stipples in the tracheal folds as well.

Etymology: This genus is named after the author's wife Mrs. Shanthini David.

Shanthiniae sheryli gen. et sp. nov. (Fig. 2)

Pupal case: Typically polyhedral, with six corners on either side. 0.68 mm long and 0.56 mm wide, widest across abdominal segment I. Black in colour with no wax secretion.

Margin: Very finely crenulate and crenate-looking, with about 4 crenulations in 0.1 mm length of margin; crenulations each much wider than long, their apices subconical to rounded or rather straight. Margin at pore area cleft. Thoracic tracheal pores well defined, inset with a single tooth-like projection. Caudal tracheal pore area not inset. Anterior marginal setae 9.3 µm long, posterior marginal setae 12.4 µm long.

Dorsum: Ornamented with spots, reticulations and minute tubercles. Submargin narrowly marked by a weak furrow. Transverse ridges and furrows running mesad from margin and submargin to anastamose in the dorsal disc area, giving a leopard skin-like appearance to the dorsum. Marginal furrows each alternated with 2-4 submarginal ones. Subdorsum granulated. Submedian area on cephalothorax and median area on abdominal segments densely spotted. Longitudinal and transverse moulting sutures reaching margin, the ends of the latter opposite meso-metathoracic suture. Base of cephalic, first and eighth abdominal setae distinct, setae very minute; bases of eighth abdominal setae located laterad of top of vasiform orifice. Caudal setae not discernible. Segmenta-tion distinct in submedian area; sutures each with anterior and posterior branches, their ends anastomosing with subdorsal reticulation. Median length of abdominal segments subequal, median length gradually decreasing from abdominal segment I-VII; that of VII as long as that of VI and shorter than VIII. Disc pores and porettes present on dorsal disc; porettes dark-rimmed and characteristically sclerotized laterad.

Vasiform orifice cordate, located about its length from posterior body margin, its sides prominent; its inner margin with teeth, especially posteriorly; 37.2 µm long and 34.1 µm wide. Operculum cordate, nearly filling the orifice; 24.8 µm long and 27.9 µm wide. Lingula concealed. Caudal furrow well defined. Caudal ridges distinct.

Venter: Thoracic and caudal tracheal folds well defined. Ventral abdominal setae 9.3 µm long. All four pairs of spiracles evident, anterior thoracic spiracles larger than others. Setae or spines on legs not discernible. Antennae reaching the base of prothoracic legs. Adhesive sacs not discernible. Rostrum distinctly segmented, setae at base absent.

Host: An unidentified plant.

Holotype: A pupal case mounted on slide, on an unidentified plant, INDIA: Tamil Nadu: Karaiyar Dam (Papanasam), 14.iv.1993. Coll: P.M.M. David (No. 180.A.).

Etymology: This species is named after the author's son D. Sheryl who often accompanied him during the survey.

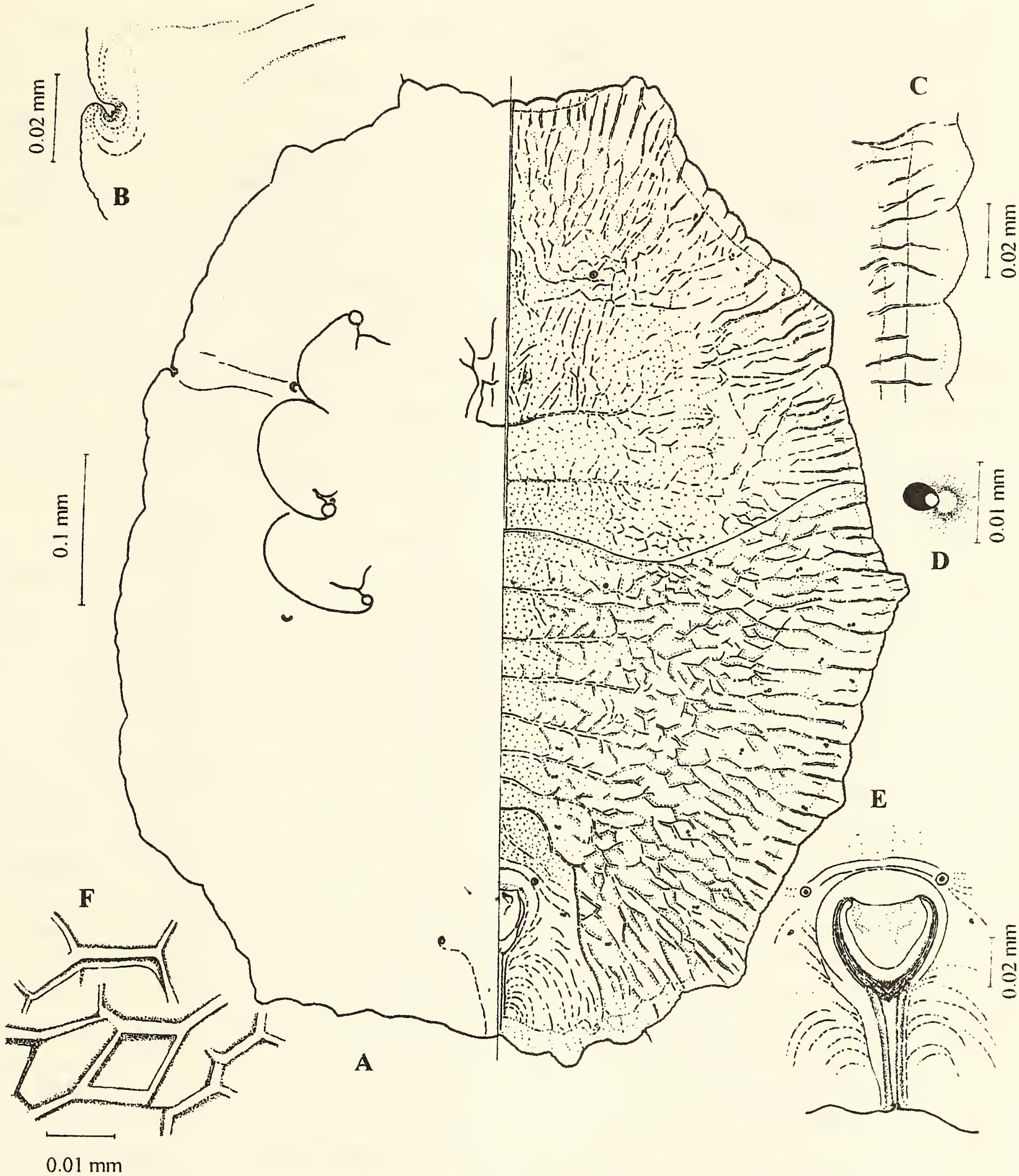

Fig. 2: *Shanthiniae sheryli* gen. et sp. nov. : A. pupal case; B. thoracic tracheal comb; C. section of margin and submargin; D. disc pore and porette; E. vasiform orifice; F. dorsal markings.

Genus ***Vasantharajiella*** gen. nov.

Type-species: *Vasantharajiella kalakadensis* sp. nov.

Pupal case oval, jet black in colour; margin lobulate; tracheal combs distinct; submargin separated from the dorsal disc by a distinct furrow not interrupted even at caudal region; marginal setae absent; submarginal setae present; first abdominal setae absent; transverse

moulting suture reaching submarginal furrow; median area of abdominal segments tuberculate; rachis on cephalothorax and abdomen present; vasiform orifice much smaller compared with its body size, subcordate, wider than long; operculum of similar shape, filling half the orifice, concealing lingula.

Diagnosis: The genus differs from such genera of Aleurolodini as *Aleuropapillatus* Regu & David, *Aleurolobus* Quaintance & Baker, *Africaleurodes* Dozier, and *Asterochiton* Maskell in the presence of complete submargin all around the case, without interruption even in the caudal region. Though it resembles the rest of the genera in the presence of the complete submargin, it is clearly distinguished from them by several characters. It is distinct from *Crescentaleyrodes* David & Jesudasan in the presence of thoracic and caudal tracheal combs and in the absence of a row of crescent-shaped pores in the submargin. Absence of first abdominal setae and a pouch-like structure at the thoracic and caudal tracheal comb area separate *Vasantharajiella* from *Rositaleyrodes* Meganathan & David. *Orientaleyrodes* David possesses very long hair-like submarginal setae, comparatively shorter median length of abdominal segment VII, much larger (80 x 75 µm) elevated vasiform orifice located only about its length from the posterior body margin. On the other hand, *Vasantharajiella* has minute submarginal setae, well defined rachis on cephalothorax and abdomen, equally long abdominal segment VII and, compared to the body size, much smaller (24.8 x 34.1 µm), non-elevated, vasiform orifice located about 10 times its length from posterior body margin. The genus also differs from all these genera in lacking anterior and posterior marginal setae.

Etymology: Named in honour of Dr. B. Vasantharaj David, Director, Jai Research Foundation, Valvada, Gujarat, as a mark of respect.

Vasantharajiella kalakadensis gen. et sp. nov. (Fig. 3)

Pupal case: Jet black in colour, surrounded by a thick fringe of white waxy filaments; powdery wax deposits on dorsal sutures and submarginal lines. Living on the upper surface of leaves. 1.82-1.86 mm long and 1.46-1.54 mm wide; widest across abdominal segments II-IV.

Margin: Lobulate, 10-11 lobulations in 0.1 mm width of margin; teeth each as long as wide. Margin at tracheal pore area slightly indented. Tracheal combs distinct; about 6 teeth at pore area larger than other teeth, with incisions in between teeth deeper than those in between other teeth. Anterior and posterior marginal setae not discernible in available specimens.

Dorsum: Submargin characteristic; complete without any interruption even at caudal region; separated from dorsal disc by a well defined furrow gradually widening caudad; approximately ½ the width of dorsal disc across the greatest width of body. Submarginal ridges and furrows distinct. A row of faint papillae-like markings evident. Submarginal setae in 13 pairs arranged in 2 rows: 4 pairs in outer submargin (2 pairs at cephalic end, one just posterior to thoracic tracheal furrow, one opposite abdominal segment I) and 9 pairs in inner submargin (3 pairs anteriad of and 6 pairs posteriad of thoracic tracheal furrow) 12.4-24.8 µm long, their bases porous, setae tapered, apices acute. Cephalic setae 15.5 µm long. First abdominal setae absent. Eighth abdominal setae 9.3-15.5 µm long, located laterad of top of vasiform orifice on a conspicuous ridge, their apices pointing towards orifice. Caudal setae 18.6 µm long, located on outer submargin anterior to the lateral tooth of tracheal comb. Longitudinal transverse moulting suture reaching margin. Transverse moulting suture curved caudad from its midpoint, recurved cephalad, terminating at submarginal furrow opposite meso-metathoracic suture. Segmentation well defined in submedian area. Median length of abdominal segments I-VI equal and of

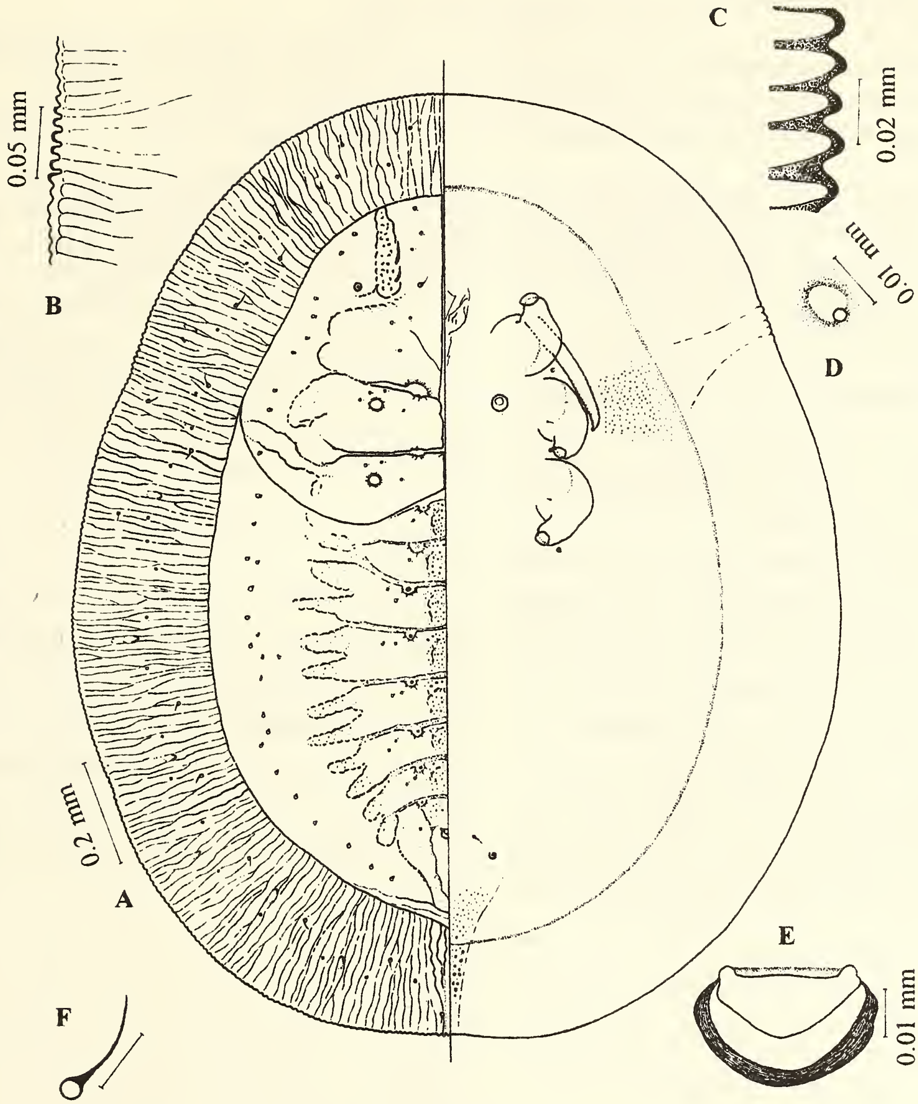

Fig. 3: *Vasantharajiella kalakkadensis* gen. et sp. nov.: A. pupal case; B. thoracic tracheal comb; C. margin; D. disc pore and porette; E. vasiform orifice; F. submarginal seta

VII shorter than that of other segments. Median area of abdominal segments I-VIII finely tuberculate. Rachis on cephalothorax and abdomen characteristic; promesothoracic suture bifurcated, each curved cephalad and caudad, recurving mesad with chain-like designs all along in subdorsal area; meso-metathoracic suture bifurcated. A somewhat transverse rachis laterad of meso-metathoracic suture; abdominal rachis III-VII each bifurcated, finger-like in inner subdorsum with chain-like designs along sutures; minute striations inside abdominal rachis. Disc

pores and porettes in a row on central submargin, in groups of 2-3 in a row each on outer subdorsum and on submedian area. Submedian depressions distinct on thoracic and abdominal segments. Pockets on abdominal segment VII inconspicuous.

Vasiform orifice very small, subcordate, located about twice its length from posterior suture and 10 times its length from body margin; wider than long, 24.8 µm long and 34.1 µm wide; its top straight, less sclerotized; sides prominent. Operculum of similar shape; longer than wide, 12.4 µm long and 27.9 µm wide, filling about half the orifice. Lingula concealed. Caudal furrow indicated by shallow depressions. Caudal ridges distinct anterior to submarginal furrow and laterad of vasiform orifice.

Venter: Tassellated. Thoracic tracheal fold marked up to submarginal line, then indicated by minute stipples; caudal fold distinct; stipples up to central submargin. All spiracles evident. Ventral abdominal setae 46.5 µm long, 31.0 µm apart. A minute seta at base of mesothoracic legs, their tips with a finger-like projection.

Host: An unidentified woody climber.

Holotype: Pupal case mounted on slide, on an undetermined climber, INDIA; Tamil Nadu: Kalakad forest, 5.i.1993. Coll: P.M.M. David (No. 208.4).

Paratypes: 11 specimens on slides bearing the same collection data as of holotype.

Etymology: Derived from the collection site, Kalakad forest.

Types Depository: The holotypes are deposited with the Division of Entomology, Indian Agricultural Research Institute, Pusa Campus, New Delhi. The paratypes of *M. rubiae* and *V. kalakadensis* are available with the Centre for Advanced Studies in Agricultural Entomology, TNAU, Coimbatore; with Dr. B.V. David, Director, Jai Research Foundation, Vapi; and with the Department of Entomology, Natural History Museum, London.

ACKNOWLEDGEMENTS

The author is grateful to Dr. M. Mohanasundaram, Professor of Agricultural Entomology (Retd.), Tamil Nadu Agricultural University, Coimbatore, for suggesting the problem and for guidance throughout the investigations, and to Dr. B. Vasantharaj David, Director, Jai Research Foundation, Valvada, Gujarat, for confirming the identity of the species, valuable suggestions and providing reprints.

■ ■ ■

LYSIONOTUS PALINENSIS — A NEW SPECIES OF GESNERIACEAE FROM ARUNACHAL PRADESH, INDIA[1]

G.D. Pal[2]

(*With one text-figure*)

Key words: *Lysionotus palinensis*, new species, Arunachal Pradesh.

During plant exploration in the district of Lower Subansiri, Arunachal Pradesh, an interesting species of the genus *Lysionotus* D. Don was collected. A critical study, based on the regional herbarium specimens of allied species and literature on species of *Lysionotus* D. Don, has proved it to be quite distinct from all known species and is described. Line drawings are provided.

Lysionotus palinensis G.D. Pal sp. nov. (Figs. : A-D)

Lysionotus serrato D. Don affinis, sed differt foliis lanceolatis ad lineari-lanceolatis, ad marginum spinulosis crenato-serratis coriaceis, pedunculis 3-7 cm longis, calieis lobis lanceolatis, 0.9-1.0 x 0.1-0.2 cm, cuspidato-acuminatis, 4-6 nervatis.

Typus: Holotypus lectus a G.D. Pal ad locum Arunachal, Inferior Subansiri district, Palin *c.* 1400 m, dia 9.ix.1983, subnumero 400, ex positus in CAL.

Shrubby herbs, 30-40 cm tall, usually unbranched, rooting at the lower nodes. Stems terete or faintly ridged, pubescent above. Leaves ternate, sometimes basal leaves opposite, lanceolate to narrowly lanceolate, 3-7 x 0.5-2.0 cm, cuneate or rounded at base, acuminate, spinulous crenate-serrate at margin, glabrous, coriaceous; young leaves hairy on nerves underneath, pale gren underneath; lateral nerves 4-6 pairs; petioles 0.2-0.3 cm long, hairy. Inflorescence laxly cymose many flowered; peduncles 3-7 cm long, terete, wiry, glabrous or sparsely pubescent; bracts ovate-lanceolate, 0.5-0.6 x 0.3-0.35 cm, acuminate, 3-nerved; pedicels 0.5-1.0 cm long, wiry, glabrous. Flowers bluish-purple; calyx lobes lanceolate, 0.9-1.0 x 0.1-0.2 cm, caudate-acuminate, 4-6 nerved, purple; corolla tubular, broad at middle, 4.0-4.5 x 0.8-1.0 cm, distinctly nerved within, reticulate at throat; upper lip 0.8 cm longer than lower lip, 3-lobed; middle lobes oblong to sub orbicular, about 0.8 x 0.6 cm, obtuse; lower lip shorter, truncate; stamens 2, fertile; filaments 0.8-1.0 cm long, flattened; anthers connivent; ovary oblong, 0.2 cm long; styles slender, 2.0-2.3 cm long, unevenly thickened. Capsules not seen.

Fl.: August-September.

Remarks: Grows in moist shaded places of subtropical primary forests on humus rich soil associated with *Impatiens, Begonia* spp.

Distribution: INDIA: Arunachal Pradesh, Lower Subansiri dist., Palin *c.* 1400 m, 9.ix.1983; G.D. Pal 400 (Holotype- CAL)

Note: The new species is closely allied to *L. serratus* D. Don, but can be differentiated by: leaves lanceolate to linear-lanceolate; spinulous crenate-serrate at margin, coriaceous; peduncles 3-7 cm long; calyx-lobes lanceolate, 0.9-1.0 x 0.1-0.2 cm, cuspidate-acuminate, 4-6 nerved.

Acknowledgements

I am grateful to the Director, Botanical Survey of India, Calcutta for facilities. I also thank Dr N.C. Majumder, ex Scientist SE, Botanical Survey of India, Calcutta for the latin diagnosis of the taxon and Dr G.S. Giri, Scientist SE, Central National Herbarium, Howrah for sketches.

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[1]Accepted December, 1998.

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Fig1. A-D: *Lysionotus palinensis* sp. nov., A. Habit; B. Corolla split open; C. Anther; D.Gynaecium with calyx.

REVIEWS

1. BIRDS OF NEPAL: FIELD ECOLOGY, NATURAL HISTORY AND CONSERVATION. by Tej Kumar Shrestha. Published by Mrs. Bimal Shrestha, Kathmandu, Nepal. 2000. Pp 287, (21 x 14 cm). Price not mentioned.

Prof. Tej Kumar Shrestha of Nepal is a prolific writer on natural history. As the jacket of his latest book BIRDS OF NEPAL claims, he is the author of the book THE SPINY BABBLER: AN ENDEMIC BIRD OF NEPAL, and other "eleven outstanding books on wildlife and natural resources". However, his books (I have read three) lack scientific accuracy and the high standard expected from a professor with a D.Sc. degree. While the quality of printing of the present book is much better than his earlier books, the language is pedantic and needs proper editing. There are too many editorial mistakes to be enumerated in this brief review.

The book claims to be a photographic field guide. There is a chapter on bird photography, (Bird-watching and Field Craft, pp. 30-38) which shows Prof. Shrestha with his various cameras, but many of the pictures are taken in zoos (e.g. plates 10-13, 17-22, 46-47, 52-53, 69), some pictures are of trapped birds (e.g. coot, Baillon's crake and Indian moorhen, plate 89, painted snipe, plate 93), and some even of mounted specimens (plates 31-32). The flight pictures on plates 33, 34 and 35 are quite interesting, and some close-ups are sharp. I particularly liked the picture of the jungle myna (plate 36). Another interesting picture is that of a male magpie robin (not foster mother as claimed in the caption) feeding a juvenile cuckoo (plate 70).

More than 250 species have been depicted in 144 colour plates and many in black & white, but identification pointers are not given in the captions. Moreover, arrangement of bird pictures is arbitrary, so to find a particular species is not easy. The most ill-conceived aspect of this book is the checklist. The author enigmatically starts his checklist with the spiny babbler *Turdoides nipalensis*, a species on which he has done his Ph.D. Since the publication of Sibley & Monroe's new classification based on DNA finger printing, there is already confusion in the classification of birds. Prof. Shrestha's book will further add to this confusion. Strangely, he has not given any valid reason for adopting his own classification.

The book covers a wide spectrum of subjects from 'Ornithography of Nepal' to 'Birds in Nepalese Literature'. Despite its many drawbacks, it is an interesting book for ornithologists and conservationists of the Indian subcontinent because birds face the same conservation problems all over South Asia. The type of trapping methods described by Prof. Shrestha in his book are also used in India. Similarly, the reasons for trapping birds (and other wildlife) and the *modus operandi* of trappers/traders in Nepal are the same as in India. Nepal is becoming the main conduit for smuggling of birds to European and Middle East markets. If this book creates awareness, this special third millennium edition would serve its stated purpose "to conserve environment and the health of people in the approaching millennium".

■ ASAD R. RAHMANI

2. BIOGEOGRAPHY OF THE REPTILES OF SOUTH ASIA by Indraneil Das, Kreiger Publishing Co., Malabar, Florida, 1996, pp. 87 + xxxvi colour plates, (24.5 x 16.6 cm). Price not mentioned.

As the title suggests, this book is a compilation of different aspects of geographical distribution of reptiles of the South Asian region.

The practice of displaying colour plates at the very beginning of the book, though not common, catches the reader's attention. All the

plates are of exemplary quality. The Montane trinket snake (*Elaphe helena monticollaris*), on the cover is excellent.

The author, at the outset, acknowledges the treatises of Smith (1931; 1935; 1943) (P. 1) to be ultimate sources of identifying the Subcontinent's reptilian fauna. He also admits drawing on the biogeographic analysis of individual countries by various workers as sources for data regarding distribution, yet does not 'necessarily' agree with them on the 'interpretation' of their findings.

The author has devoted an entire chapter to apprise the reader of the methods used in his analysis. He also points out that the status of nomenclature and species reallocation is in great turmoil and uncertainty. Thus, it is safe to assume that a more exhaustive study comprising of valid names, distribution and species reallocation is to follow.

The descriptions of the physiographic zones within the South Asian region, first from the physical and biological point of view and then solely on the basis of faunal characteristics like biodiversity and endemicity, are very informative and give a detailed view of the South Asian region.

The results obtained and subsequent discussions on (a) Biodiversity and Endemicity (b) Faunal characteristics of physiographic zones (c) Patterns and correlates of diversity (d) Affinities between physiographic zones (e) Affinities with extralimital fauna (f) Barriers and speciation (g) Disjunct distribution of taxa, are written in a lucid style.

A map is used in Chapter 3 to depict the physiographic zones. A tree-diagram effectively explains the affinities between physiographic zones. Graphs have been used to interpret or express certain data. The presence of a map and graphs depicting the physiographic zones makes it easier to visualise the explanation given. These aids make the initial chapters very informative and interesting.

The analysis is complete, but as the author himself points out, the checklist can be the basis of a more exhaustive study owing to the instability of the taxonomic arrangements and interpretation.

■ MEGHANA GAVAND

3. MOSSES OF KHANDALA AND MAHABALESHWAR IN THE WESTERN GHATS (INDIA) by G.T. Debhade, Published by A.S. Dalvi, Thane, 1998. Pp. iv + 193, (25 x 18.5 cm). Hardbound price Rs. 800/-, $ (US) 40.

The mosses and in fact the entire group of Bryophytes are neglected, though they have an important bearing on the evolutionary history of the plant kingdom. The very fact that the bryophytes represent the transitional zone between the amphibian and the terrestrial habit, and that they may, perhaps, be the base in the origin and the organisation of the reproductive machinery of other plant groups from pteriodophytes to angiosperms, explains the importance of the Bryophyta in comparative morphology, ecology and phylogeny. Inspite of the academic importance and even economic value, the group remains neglected and it is in this context that this publication becomes significant.

The work, though confined to a certain region of the Western Ghats, is of value in the identification of many mosses in the entire Western Ghats. The author has painstakingly made field collections and described them, giving information on characters of diagnostic value, with particular reference to the capsule and even the spores at times. Altogether, 87 species under 48 genera and 27 families have been covered.

The general introduction, the review of previous work and the scope of the present work, together with the table containing salient

information on the concerned taxa, give valuable information on phytogeography and ecology of the mosses in South India. The author has given information on the physiographic, edaphic and environmental conditions of the areas covered by the present study, followed by an account of methodology of collection, preservation and identification, including preparation of permanent slides of the whole plants and their parts, including spores. The morphological analysis, both mega and micro-characters, provides a picture of the thoroughness and depth of research that the author has carried out.

The descriptions are followed by a general analysis of various aspects of the study which, perhaps, is the best part of the publication. The information on habitat shows the location-specific occurrence of mosses on calcareous, lateritic, or peaty soils, and such information is of immense environmental importance for using mosses as bio-indicators. Further, information on moss sociology is in fact a reflection of biodiversity combinations in various micro-ecosystems. The account on geographical distribution gives very useful data on the abundance or rarity of various taxa. The finding of a large number of endemic species in the restricted area of Khandala and Mahabaleshwar should receive conservative attention to help save these species from extinction. The concluding sentence "As we go south, more and more humid species begin to appear and as one goes northwards, drier species are met with" holds good for the Western Ghats of India as a whole.

It is my considered opinion that the work is of high academic merit and a useful reference book for field botanists working with mosses.

■ P.K.K. NAIR

■ ■ ■

MISCELLANEOUS NOTES

1. INSTANCES OF FRUIT BAT MOBBING THE BARN OWL

On the night of September 16, 1997, my family and I were watching the total lunar eclipse from our terrace garden at Sion, Mumbai. A pair of barn owls (*Tyto alba*), which were nesting in the rafters of the building next to our house, had the habit of perching on a tree opposite our house. The canopy of the tree was at eye level from our terrace garden on the 3rd floor. Fruit bats or Indian flying foxes (*Pteropus giganteus*) regularly fly all around the area, coming in large numbers mainly from their huge roosting sites at Five Gardens, Dadar, Mumbai.

As we watched, a bat started mobbing one of the owls perched on the topmost branch. The owl immediately ducked and turned its face nearly upside down to look at the attacker. At the same time its mate, which was sitting on a lower branch, gave a loud squawk of protest. The bat then wheeled around and once again came to mob the first bird which ducked out of danger. The owl refused to fly away or move down to the lower branches. This went on for about 10 minutes wherein 17 attempts were made by the bat, out of which about 12 resulted in contact. At least 5 times the bird was nearly dislodged from its perch. We could clearly see that all the mobbing by the bat was done with its wings. All the time both the birds were calling regularly.

The second bird then took off and sat on an adjacent tree, while the first bird was still perched in its original place. A few minutes after the second bird left, the bat was joined by three others, and all four started mobbing the first bird. The second bird then started screeching and flew over its mate in an attempt to protect it. The first bird then gathered enough courage to fly off to its roosting place in the rafters of the next building.

It was amazing that, inspite of such continuous mobbing, the owl which was being mobbed rarely flew off, and its only evasive action was to duck. The bird flew away only when its mate came to help, or when the mobbing became unbearable. I am quite sure that both the birds were adults, not a protective parent and its offspring.

It was lovely to see this drama as well as the total lunar eclipse. Instances like these have been regularly sighted by us, at least once a week, even to the date of writing this note.

ACKNOWLEDGEMENT

I am grateful to Dr. A.R. Rahmani, Director, Bombay Natural History Society. for his guidance, help and valuable suggestions.

March 2, 1998

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2. POSSIBLE OCCURRENCE OF THE LESSER WOOLLY HORSESHOE BAT *(RHINOLOPHUS BEDDOMEI)* IN CHINNAR WILDLIFE SANCTUARY

During a short visit to Chinnar Wildlife Sanctuary, Kerala, in October 1997, some members of my group found a black bat hanging from the doorway of a building at the Chinnar checkpost one evening. The surrounding habitat included riparian gallery forest and light deciduous forest. Judging from the appearance of its face, the bat appeared to be insectivorous, equipped with echolocating apparatus. For a microchiropteran, it was a large animal, and appeared black overall. The next morning, it was found roosting alone in a dark corner near the ceiling of the same building.

Using BATS OF THE INDIAN SUBCONTINENT by Paul Bates and David Harrison, I tentatively identified the bat as *Rhinolophus beddomei*, the

lesser woolly horseshoe bat, on the basis of its large size, colour, habitat and solitary occurrence.

I had an occasion to visit Chinnar again in June 1998. I found a bat, presumably the same individual, roosting at the same place as it had been doing nine months earlier. Even with a moderately bright torch, no further details could be noted to ascertain its identity. I was, however, able to photograph it using a flash this time.

The photograph strengthens the impression that the bat is indeed a lesser woolly horseshoe bat. The animal is seen to be hanging by one leg, which is a habit characteristic of that species. Further, Dr. Paul Bates, who studied this picture wrote that he thought it was *Rhinolophus beddomei.*

The lesser woolly horseshoe bat is endemic to peninsular India and Sri Lanka. In Kerala, it has hitherto been recorded from Wynaad, Tellicherry, Trichur district and Palghat. This report constitutes a possible new record of a species which has been described as very vulnerable to habitat destruction on account of low density populations and forest dependency.

On a later visit to the same place in February 1999, I could not find any bat.

March 23, 1999

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3. DEAD SNOW LEOPARD *UNCIA UNCIA* AT YABUK, DONGKUNG (5500M) IN NORTH SIKKIM

Snow leopard *Uncia uncia* is protected in Schedule I of the Indian Wildlife (Protection) Act, 1972 as amended upto 1998. There are almost no recent sight records of this rare big cat from Sikkim, the last being a cub from Sebu La region in Lashar valley, north Sikkim. The male cub 'Shebu' survived for less than a year in captivity in Gangtok in 1993-1994. There has been no study so far on its present status in Sikkim.

On November 18, 1998, a Tibetan grazier or 'dokpa' was attracted by a hovering raven while grazing his yaks at Yabuk (*c.* 5500m), a rocky place about 2 km above Dongkung, at the foot of Chomiomo peak on the Chho Lhamo Plateau. Upon investigating, he saw what he thought was a sleeping, probably sick, snow leopard in the grass at the base of some large boulders. Sensing something was wrong, he drove away the raven and went closer. He found it was an adult male snow leopard lying dead in sleeping posture. The spot was very isolated and intending to return the next day to collect the specimen to bring down to me in Gangtok, he went back to his camp.

Unfortunately feral dogs discovered the carcass. The next day, most of the softer parts, the internal organs and the ribs had been eaten away. The grazier collected the remains. Almost in the same sleeping posture, most of the carcass except the head and shoulders dried naturally in the cold of this desert area. Six months later, on May 16, 1999, he brought the remains down to Gangtok in a highly decomposed state and deposited them in the Wildlife Circle of the Department of Forests, Environment & Wildlife. The heat accelerated putrefaction and we tried to save the specimen as much as possible by skinning. On examining the jaws of the snow leopard, we saw that the upper left canine was missing, as was one incisor in the upper jaw. The other teeth were also worn out and yellow: The claws were blunt. The front pad in the pug measured 8.5 cm and the hind, 8 cm. The tail measured 92 cm and had a diameter of *c.* 13 cm. The bones were buried in the ground to remove the tissue. They were later cleaned and measured (Table 1).

TABLE 1
SKULL MEASUREMENTS OF SNOW LEOPARD (IN MM)

Total length	171	
Condylobasal length	145	
Zygomatic width	122.5	
Post Orbital Width	44.9	
Inter Orbital Width	40	
Maxillary Width	72.5	
Mandibular Length	115.2	
	Upper jaw	Lower jaw
Premolar 4	13.88	16.1
Molar 1	21.25	16.15

The 'dokpa' grazier had two previous sightings of snow leopard in this area. On July 27, 1998 it was sighted at Dongkung. It was last seen alive at Yabuk on September 10, 1998. He also recorded sightings of upto 30 blue sheep *Pseudois nayaur* in this area. Around 1100 yak and 2000 sheep belonging to 18 'dokpa' families also use the area.

Feral dogs have long infested the entire area where this animal was found. These dogs were brought to the Tibetan plateau as pups from lower altitudes by the army jawans for company. On finishing their stint in this 'difficult area' all the dogs were abandoned. These have since bred with the local Tibetan mastiff and multiplied by feeding off the kitchen wastes of the army camps. Today these feral dogs roam in packs on the plateau, living off marmots, woolly hare, Tibetan gazelle, blue sheep, young nayan and kiang as also domestic sheep, goats and young yak including those animals which have been lamed by landmines. Usually nothing is done to control their number. Needless to say, pure breed of Tibetan mastiff, which is a master herder, also seems to have been irretrievably lost. It is difficult to quantify the feral dog population as the entire area, though under the jurisdiction of the Department of F. E. & WL, is under defence control, where civilian activities are severely and actively restricted.

All wildlife and domestic livestock on the Tibetan plateau of Sikkim are under severe stress due to various defence priorities. This area, known as the Chho Lhamo plateau, is perhaps the only one in the entire eastern and central Himalayas to have breeding populations of endangered species such as the southern kiang *Equus kiang polyodon*, lynx *Lynx lynx* and blacknecked crane *Grus nigricollis*, in addition to snow leopard — all listed in Schedule I of the Indian Wildlife (Protection) Act. The richness of the region has prompted the State Wildlife Advisory Board to propose its recognition as a cold desert protected area.

July 27, 1999

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4. ON THE LONGEVITY OF THE TIGER (*PANTHERA TIGRIS*) IN CAPTIVITY

A white tigress named Diana-Subhra born at the National Zoological Park, New Delhi, on June 6, 1977, was received at the Nandankanan Zoological Park, Bhubaneswar, Orissa, on December 28, 1979. She died on February 28, 1999, after remaining 21 years, 8 months and 22 days in captivity.

The tigress was housed in an open-air enclosure with suitable vegetation. The enclosure had a set of retiring cells with cemented floor for protection from extreme weather conditions and for feeding. She was fed with 14 kg of fresh raw beef with bones six days in a week. Intermittently, vitamin supplements were added to the beef. She was usually caged with her mate or her cubs.

During her lifetime in the park, she was paired with two tigers (one heterozygous normal coloured "Deepak" and one white "Debabrata") and she gave birth to 16 cubs (6 males and 10

females) in six litters, including three heterozygous normal coloured female cubs. The first litter was born on May 12, 1981 and the sixth litter on April 23, 1990.

According to Roychoudhury *et al.* (1989), the two white tigresses Mohini and Chameli born at Govindgarh Palace, Rewa on October 30, 1958, and March 24, 1962, died at Washington Zoo (U.S.A.) on April 6, 1979, and at Bristol Zoo (England) on August 23, 1982, at the age of 20 years, 5 months, 7 days and 20 years and 5 months respectively. A female Bengal tiger at the New York Zoological Park died at the age of 20 years, 7 months and 2 days (Crandall, 1965). A tigress of Alipore Zoological Gardens, Calcutta lived for 20 years and 3 months (Das, 1983). Under zoo conditions, the maximum longevity of tigers is 20 years, an age which is probably not exceeded in the wild (Schaller, 1967). The estimated life span of the tiger is about 20 years (Prater, 1971). Tigers have lived in captivity for 12 to 19 years (Walker *et al.*, 1964).

Flower (1931) says that there appears to be no definite record of a tiger living to 20 years and the greatest longevity listed by him is that of a Siberian tiger that lived for 19 years in the Cologne Zoological Gardens. A tigress had lived for 19 years in the Zoological Gardens, Thrissur (Nair, 1957). A tiger of Nandankanan Zoological Park, Bhubaneswar died at the age of 18 years, 6 months and 10 days (Acharjyo and Patnaik, 1987).

Diana-Subhra's longevity of 21 years, 8 months and 22 days in this Park appears to be the longest so far recorded for this species in captivity.

September 9, 1999

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5. SIGHTING OF BARKING DEER *(MUNTIACUS MUNTJAC)* IN KALAKAD-MUNDANTHURAI TIGER RESERVE, TAMIL NADU

As part of our biodiversity studies, we were surveying the flora and fauna on the Mundanthurai Plateau, part of Kalakad-Mundanthurai Tiger Reserve in Tirunelveli dist., Tamil Nadu. On October 15, 1997, the second day of our field work, one of us (JR), after completing sampling at three

points for quantifying vegetation, moved on to the next point. Just near the fourth point, the sound of an animal running and at the same time one of our assistants shouting *Khaleyaad* (barking deer in Tamil) was heard. What one of us (JR) saw was a reddish brown deer, smaller in size, and somewhat different from a sambar or a spotted deer. Since it had antlers we knew it was a male. Our assistants showed us the place where it had been resting. It was under a *Grewia hirsuta* tree with sparse grass. We went to that site, had a closer look and found some hairs, which we collected and sent to the Wildlife Institute of India, Dehra Dun, for identification.

Back at the field station, we checked THE BOOK OF INDIAN ANIMALS (Prater 1971, p. 324). Our opinion that it could be a barking deer was confirmed. In addition, the hair sample also identified it a barking deer. It was really surprising to have seen a barking deer at Mundanthurai, as there have been no earlier records of its presence. Dr. A.J.T. Johnsingh, who has been working in this area for almost 30 years has not seen or even heard this deer (pers. comm). In addition, Dr. S.F. Wesley Sunderraj and one of us (JJ) have been working in this area since 1984, and have never seen or heard this deer before. In the past two years in KMTR, we have not heard or seen this deer. Our assistants, local Kanni tribals, say that they have seen this deer thrice near Kodamadi, beyond Servalar dam, while repairing the road in 1992.

Mundanthurai plateau, covering an area of *c.* 60 sq. km, retains mainly dry deciduous and open scrub forest with grass patches. The altitude is 204 m above msl. The animal was sighted near Tambraparni river adjacent to the Deer Valley.

In addition, one of us (JJ) sighted a female and J. Ronald sighted three, two adults (sex unidentified) and one yearling barking deer in the Kadayam range in the northwestern part of the Reserve.

Our sighting is the first of this deer on Mundanthurai plateau. We suspect that barking deer could have moved in from the Kodayam range which lies further northwest of the Reserve. More sightings of barking deer are needed to confirm the new addition of this ungulate species to the fauna of the Reserve.

July 27, 1999

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6. TYPE SPECIMENS OF MAMMALS IN THE COLLECTIONS OF THE BOMBAY NATURAL HISTORY SOCIETY

The mammalian type specimens present in the collections of the Bombay Natural History Society as on June '99 are included. The Society has a collection of 18,500 mammal skins and skulls. Most of the specimens were collected during the Mammal Survey of India undertaken by the Society from 1911 to 1928. The present note deals with the type specimens in the collections. The collection data has been transcribed from the labels.

CHIROPTERA

PTEROPODIDAE

PTEROPODINAE

Cynopterus sphinx gangeticus Andersen, 1910

Ann. Mag. Nat. Hist. 6: 623

Type: BNHM 1651, *cotype*, juvenile female, from "Chanda" (in Maharashtra, western India) at about 500 ft.

Date of collection: September 1908

Collector: Major A. Begbie

Measurements: HB-153 mm, HF-17 mm

Current Status: *Cynopterus sphinx* (Vahl, 1797). Wilson and Reeder (1993).

CHIROPTERA
PTEROPODIDAE
PTEROPODINAE

Latidens salimalii Thonglongya 1972.

J. Bombay nat. Hist. Soc. 69: 153

Type: BNHM 1563, *holotype* from "High Wavy Mountains, Madura district, South India at about 2500ft.

Date of Collection: 2 May 1948 (Registration - 11 June 1948)

Collector: A. F. Hutton

Current Status: *Latidens salimalii* Thonglongya, 1972. Bates and Harrison (1997).

Remarks: *Latidens salimalii* is endemic to India.

CHIROPTERA
HIPPOSIDERIDAE

Hipposideros hypophyllus Kock & Bhat, 1994.

Senckenbergiana biol. 73(1-2) : 25-31

Type: BNHM 18363, *paratype*, female, from "Hanumanhalli, Kolar District, Bangalore, Karnataka, India".

Date of Collection: 7 March 1985

Collector: H.R. Bhat

Current Status: *Hipposideros hypophyllus* Kock & Bhat, 1994. Bates and Harrison (1997).

CARNIVORA
FELIDAE
FELINAE

Felis libyca iraki Cheesman, 1921.

Felis ocreata iraki Cheesman, 1921.

J. Bombay. nat. Hist. Soc., 27: 331-332

Type: BNHM 5981, *paratype*, male, from "Sheikh Saad" (Iraq).

Date of Collection: 08-12-1916

Collector: Cox & R.E. Cheesman

Current Status: *Felis silvestris* Schreber, 1775. Wilson and Reeder (1993).

Remarks: Revised by Ragni & Randi (1986), who included *libyca* under *silvestris*. Smithers (1983) & Meester *et al.* (1986) retained *libyca* as separate from *silvestris*.

ARTIODACTYLA
TRAGULIDAE

Tragulus meminna Erxleben, 1777.

Moschus meminna Erxleben, 1777.

Syst. Regn. Anim., Mamm. 322.

Type: BNHM 17180 *topotype*, female from "Kissaraing Island" (Mergui Arch., Burma).

Date of Collection: 29 September 1921

Collector: C. Primrose

Measurements: HB-370mm, Ear-32 mm, HF-115mm, Tail-57mm

Current Status: *Moschiola memina* (Erxleben, 1777). Wilson and Reeder (1993).

ARTIODACTYLA
TRAGULIDAE

Tragulus javanicus lampensis, Miller, 1903

Proc. Biol. Soc. Washington, 16:42

Type:BNHM 17838, *topotype*, male from "Sullivan Islands" (Mergui District, Burma).

Date of collection: 5 March 1922

Collector: C. Primrose

Measurements: HB-459mm, Ear-34mm, HF-116mm, Tail-62mm

Current Status: *Tragulus javanicus* (Osbeck, 1765). Wilson and Reeder (1993).

June 4, 1999

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7. NIGHT HERONS AND LITTLE CORMORANTS IN THRISSUR, KERALA

Night herons (*Nycticorax nycticorax*) and little cormorants (*Phalacrocorax niger*) are communal nesting local migrants which usually build nests in trees that adjoin, or are actually standing in water bodies. These birds are seen in Southern India from November to February, their breeding season. When faced with water scarcity or disturbance of the nesting grounds, the birds are known to desert traditional nesting sites and move to other suitable places. But this year in Kerala, the birds were spotted in hundreds, nesting in tall mango and jackfruit trees in the densely populated Keerankulangara area of Thrissur town, Kerala. With no large water body nearby, the birds had to depend on the nearby ponds, water tanks and even local markets for their fish. Their cries and the stench of the droppings have made them a nuisance to the local residents who are even contemplating shooting them! The disturbance of their traditional breeding grounds like Kumaragam and adjoining areas could be the cause of this invasion. An inquiry into the cause and a speedy solution are necessary to ease the problems of the residents and also ensure the safety of the birds.

March 30, 1998

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8. GREY HERON WRESTING FISH FROM HERRING GULL

On February 14, 1998, I saw something so unusual that it is worth reporting. Normally it is gulls that chivvy other birds and deprive them of their prey. On this occasion, the tables were effectively turned. My attention was drawn to a grey heron (*Ardea cinerea*), a herring gull (*Larus argentatus*) and a gullbilled tern (*Gelochelidon nilotica*) in turmoil. At first I thought the heron was being harried, but it soon became apparent that it was the heron who was chasing the gull, who was being further harried and prevented from making a getaway by the tern chivvying it from above. The gull was weighed down by a fish in its beak. The skirmish continued for several minutes, the three birds in the air a few feet above the tidal mud. Finally, the gull let go

of the prize and the heron settled to take over the prize before the gull could turn and retrieve it. Both the gull and the tern alighted on either side of the heron to watch it swallow the fish.

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9. ADDITIONAL SITE RECORDS OF BLACK STORK *CICONIA NIGRA* (LINN.) IN ANDHRA PRADESH

Manakadan (1987) reported sighting of black stork *Ciconia nigra* (Linn.) near Rollapadu in Kurnool dist., Andhra Pradesh. As per the literature available, the distribution of this stork has not been reported from south of Maharashtra (Ali and Ripley, 1983) except for Manakadan's report from Andhra Pradesh, Perennou and Santharam (1990) from Tamil Nadu and Henry (1971) from Sri Lanka.

We further add that the black stork has been recorded by us at various places in Andhra Pradesh on the banks of River Godavari and its branches in East Godavari dist. A pair was first sighted along the banks of River Gouthami near Ravulapalem in Jan. 1987. Subsequently, 4 birds were recorded near Mandapalli in Dec. 1989; 3 near Kumarajulanka in Dec. 1992 and 6 near Ravulapalem in Jan. 1995. These additional site records of black stork from Andhra Pradesh are worth noting.

Acknowledgements

We thank Prof. J.V. Ramana Rao for guidance and valuable comments, Dr. B.M. Parasharya for showing his interest in our findings and going through the manuscript, and the Ministry of Environment and Forests, Government of India, New Delhi for financial assistance.

March 17, 1998

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10. STEALING OF REDWATTLED LAPWING *VANELLUS INDICUS* (BODDAERT) AND YELLOW-WATTLED LAPWING *VANELLUS MALABARICUS* (BODDAERT) EGGS BY COWHERDS

During a study on the nesting habits of the redwattled lapwing *Vanellus indicus* (Boddaert) and the yellow-wattled lapwing *V. malabaricus* (Boddaert) at Brindavan and its environs at Kadugodi, located about 22 km from Bangalore, Karnataka, we observed that one of the reasons for loss of eggs in these species was the collection of eggs by cowherds. The local cowherds were observed searching for lapwing nests during the dry season. The nests could be

located by observing the parent birds, which were very vocal. After collection, the eggs were covered with cowdung, roasted in a fire made of dry twigs and eaten by the cowherds. Though other predators like dogs, mongoose, snakes and foxes were sighted in the nesting area, the cowherds alone caused a loss of 61% and 8% eggs of redwattled and yellow-wattled lapwings respectively, in the 19 and 10 nests observed for each species.

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11. A NOTE ON THE FEEDING OF LESSER COUCAL (*CENTROPUS TOULOU*)

In 1994, I had discovered a small breeding colony of lesser adjutant stork in Kahala village, about 48 km from Malda, West Bengal. On March 16, 1997, I was watching a parent bird feeding a rather large young one by regurgitation. I saw that some food had slipped to the ground from the nest. About 10 minutes later, when I reached the nest to identify that food item, I found that a lesser coucal *Centropus toulou* (identified by its small size and white tipped tail feathers) was feeding on the same item. In five minutes, it devoured about 1/6th to 1/8th of the morsel. Suddenly a village dog approached and the bird flew away.

On a closer look, the food item was found to be a fish (*Mastacembelus armatus*). According to the HANDBOOK (Ali and Ripley 1987, Compact Edn. Oxford University Press, Bombay), the lesser coucal feeds almost entirely on grasshoppers, so fish is a new dietary item for this species.

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April 3, 1998 SAMIRAN JHA
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12. OCCURRENCE OF THE YELLOWBROWED BULBUL *HYPSIPETES INDICUS* (JERDON) IN THE NALAMALLA HILLS, ANDHRA PRADESH

The yellowbrowed bulbul *Hypsipetes indicus* (Jerdon) is a common resident of Western Ghats affecting evergreen biotopes above 900 m (Ali and Ripley, 1983) and has been recorded from the Eastern Ghats first by Taher *et al.* in 1990 from Tirumala Hills (Taher and Pittie, 1994). Santharam (1992) reported it from Mamandur (Chittoor dist.) and Karthikeyan (1996, 1997) at Kolli Hills (Tamil Nadu). These records indicate that the yellowbrowed bulbul is more or less restricted in distribution to Western Ghats and has been occasionally reported from southern Eastern Ghats. We report its occurrence from the Nalamalla Hills further north from the hitherto reported range in Eastern Ghats. While birding at Umamahesharam near Mannanur in Nagarjunasagar-Srisailam Wildlife Sanctuary (or Rajiv Tiger Reserve), Mahboobnagar dist. during April 1997, we came across a pair of yellowbrowed bulbul busily feeding. The species was easily identified, based

on its conspicuous olive yellow above and bright yellow head and underparts. Earlier, we had an opportunity to observe this species at Periyar Wildlife Sanctuary (Kerala). This is the first record of the yellowbrowed bulbul *Hypsipetes indicus* from the Nalamalla Hills in Nagarjunasagar-Srisailam Wildlife Sanctuary, Andhra Pradesh.

ACKNOWLEDGEMENTS

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March 17, 1998

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13. TERMITE ATTACK ON NEST MATERIAL LEADING TO DESERTION OF EGGS BY BIRDS

A study was conducted on the nesting success of the birds at Brindavan and its environs, located about 22 km east of Bangalore, Karnataka. One of the factors responsible for the loss of eggs was found to be abandoning of eggs by parents subsequent to termite attack on nests of the singing bush lark *Mirafra cantillans* Blyth, blackbellied finch-lark *Eremopterix grisea* (Scopoli); pied bush chat *Saxicola caprata* (Linn.), and the large pied wagtail, *Motacilla maderaspatensis* Gmelin. In all these birds, the termites destroyed nest material, as a result of which the eggs were buried in the encrusted mud. In the case of the singing bush lark and the large pied wagtail, the nesting parents made an unsuccessful attempt to incubate half exposed eggs, but later abandoned the nests. However, in the case of the blackbellied finch-lark, the parents continued to incubate the eggs, inspite of the nest material being attacked by termites. The nestlings were present in the nests and were being fed by their parents. Termite attack on nest material leading to desertion of eggs has not been reported earlier.

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14. RANGE EXTENSION OF THE PURPLERUMPED SUNBIRD *NECTARINIA ZEYLONICA*

While preparing an overview of the birds of Gujarat for the Dr. Sálim Ali Centenary issue of the *JBNHS*, I was struck by how very little qualitative information existed on the natural history of our region. We really have very generalised knowledge of bird distributions; it therefore becomes all the more pertinent to suggest to friends, particularly those on weekend birdwatching excursions, to record all the birds they come across. I have been writing brief notes on seemingly small observations, which can indeed change many of our perceptions. We must be cautious in recording new species and not be casual about seemingly common-place species.

I have been particularly careful to look at every sunbird coming my way and in doing so, have been rewarded with recording a purplerumped sunbird *Nectarinia zeylonica* in Ahmedabad on February 5, 1998. In my overview I had noted "Sálim Ali has only a single unconfirmed sight record" and had gone on to suggest that "resident birdwatchers of Vadodara and Surat may well come across a good many more". Unless seen in extremely even light, sunbirds do not reveal their scintillating colours, no doubt because the iridescence is due to refraction of sunlight rather than pigmentation.

For *Nectarinia zeylonica* Ripley (1982) sums up: "Range — Peninsular India from Nasik in a line east to Jabalpur and east to East Pakistan at Dacca, south in Bombay (sight record for Panchmahals Dist., Gujarat...) MP., Orissa, Andhra to Goa, Mysore, Madras and Kerala..." Ahmedabad is way north of the believed range, though it is significant that the coastal plains north of Bombay have no limit indicated and I suspect this species is commoner than believed in southern and central Gujarat.

By this note, I would like to convince amateur birdwatchers to scrutinise the common birds of their areas. Had I not, for example, paused to look at a small group of apparently purple sunbirds *N. asiatica* at the Centre for Environment Education (CEE), I would not have had the pleasure of seeing a bright male *zeylonica*. The sunbirds were fluttering under the shrubbery just outside the window — agitated perhaps, by some cat or snake. There were a couple of fully plumaged *asiatica* males contrasting nicely with the bird under review. Significantly, the purplerumped sunbird, according to Ali (1996) has no well defined nesting season, but I am tempted to believe that in the northern parts of its range, breeding coincides with the flowering of our native trees, shrubs and climbers as it does with the other three sunbirds of the genus *Nectarinia*: the small *N. minima*, the maroonbreasted *N. lotenia* and the widespread purple *N. asiatica*. In conclusion, in Gujarat we need to keep a watch for *minima* and *lotenia* which, like the purplerumped sunbird, may be more widespread than hitherto believed.

March 24, 1998

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15. WATER ACQUISITION STRATEGY ADOPTED BY GOLDFINCH (*CARDUELIS CARDUELIS*)

Water is an important requisite for survival. The daily intake of water depends on a wide range of environmental and physiological variables (Welty 1982). Grain eating birds gain little water from their food and are said to have the greatest need for water (Dorst 1974). Goldfinch are granivorous and mainly feed on seeds, especially of thistles (*Carduus* spp.), sunflower (*Helianthus*) and zinnia (*Zinnia*) in hill station gardens, and seeds of the chenar tree (*Platanus orientalis*) in Kashmir (Ali & Ripley 1983). Thus it has to fulfill its water requirements by drinking water regularly.

Here I report my observation of goldfinch eating snow. They were seen on February 24, 1997, at 2800 m above msl, on the southern boundary of the Kedarnath Wildlife Sanctuary on (30° 30' N & 79° 15' E). The Sanctuary remained snowbound from January to March. Goldfinch have been reported to be fairly common in the study area (Green 1985). Seven goldfinches were observed on a rhododendron (*Rhododendron arboreum*) tree near a frozen *nalla* (forest stream). They were seen feeding on the seeds of a dead thorny herb (*Mollina longifolia*) growing nearby. After a while, a few birds were observed chipping off the snow on the ground with their beaks and then consuming it. This method of consuming water in frozen form has been reported in other species such as starlings (Allard 1934), pine siskins (*Carduelis pinus*), redwing (*Turdus iliacus*), blackbird (*Turdus merula*) and Bohemian waxwing (*Bombycilla garrulus*) (Wolfe 1997).

March 12, 1998

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16. OCCURRENCE OF DRACO OR FLYING LIZARD *DRACO DUSSUMIERI* IN CHITTOOR DISTRICT, ANDHRA PRADESH

Two days (August 28-29, 1999) of the first Bird Banding Training Programme for the 1999-2000 season, organised by the Bombay Natural History Society (BNHS), were spent in Talakona Reserve Forest (13°49' N, 79° 13' E), in the Palkonda hills of the Eastern Ghats complex. Talakona is *c.* 70 km northwest of Tirupati town in Chittoor dist., Andhra Pradesh. It is part of the 506 sq. km Sri Venkateshwara National Park. Within Talakona RF is a 5 sq. km sacred grove around the temple of Siddeswaraswamy. A perennial stream, *Bugga Vágu*, plunges 30 m, forming the Talakona or Papanásanam Waterfall, into a narrow valley supporting a belt of semi-evergreen riparian vegetation, along a length of at least 3 km, which is the distance from the temple to the waterfall (Anon., 1996).

While returning from an early morning

birdwatching trek to the waterfall on August 28, 1999, Aasheesh Pittie sensed a movement among the trees growing from the valley on his left and on looking saw a small object floating towards the trunk of a tree. He wondered whether it was a flying lizard. The orange coloured patagium was seen clearly. Before he could focus his binoculars on it, the lizard merged into the bark of the tree. A few steps ahead, S. Balachandran pointed out a male draco *Draco dussumieri* Dum. & Bibr., on the vertical trunk of an unidentified tree (*Mangifera indica?*), that grew from the valley below. The lizard was displaying by erecting a bright yellow flap of skin from the region of its throat. But for this flash of brilliant colour, it would have been difficult to spot the draco against the bark of the tree, as its camouflage was perfect. We spotted two more lizards while we stood there. One was on another tree about 5 m away and the other was on the same tree as the first lizard. All three were at eye level and we had a good view of them. Three to four lizards were also seen next morning in the same area. They were photographed and videographed by other members of the group.

According to Daniel (1983) *Draco dussumieri* has a distribution that is "restricted to southwest India from the hills near Kanyakumari to the forests of Goa...All other species of the genus *Draco* occur in the eastern Himalayas and further east." Though the lizard is listed in the publicity pamphlet on Sri Venkateshwara NP, brought out by the Andhra Pradesh Forest Department, this is the first documentation of its occurrence in the Eastern Ghats, an interesting record for biogeographers of the Oriental Region.

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November 4, 1999

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17. OCCURRENCE OF YELLOW-BELLIED *PELAMIS PLATURUS* (LINN.), REPTILIA : HYDROPHIDAE, IN COASTAL WATERS OFF DIGHA, WEST BENGAL

A specimen of the yellow-bellied sea snake *Pelamis platurus* (Linn.) of 235 mm total length was caught in a dragnet by fishermen off Digha, West Bengal, from the Bay of Bengal on September 12, 1998. Although this species is common in the Indo-Australian seas (Smith, 1943), there is no mention of this species in the account of Ahmed & Dasgupta (1992), who listed the reptiles of West Bengal. A brief description of the specimen is given below:

Pelamis platurus (Linn.)
Anguis platurus Linn. 1766,
Syst. Nat. ed. *12, p. 391.*

Material examined: New Digha Ghat, West Bengal, India; 12.ix.1998; coll. S. Mitra &

S. Ghosh, MARC. Regn. No. 86.

Diagnostic characters: Head narrow, snout elongated, body much compressed, tail laterally compressed, scales more or less hexagonal, 52 scale rows on thickest part of body, the lowermost rows with two small tubercles.

Colour: Blackish brown above, ventral portion bright yellow, a narrow yellow ring just below head, another two on body. Tail with 10 cream-white stripes.

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18. A RECORD AUDIO FEAT BY AN ANURAN

While staying in a sanitarium near Igatpuri (Nashik dist, Maharashtra), in the late summer of 1993, I came across an interesting, non-stop audio feat by a frog. Unfortunately at that time, I could not identify the species, for it was calling from the middle of a large, extensive waterlogged patch which was almost inaccessible. But in later years I came across similar feats, first in August 1998, in the Pune University Campus and secondly from an inundated ditch atop a hill near Pune in June 1999. In the second instance I was able to catch the frog and identified it as the colourful fungoid frog (*Rana malabarica* Bibr.)

In the case of the Igatpuri frog, I first heard its shrill call on the evening of June 6, 1993. The previous two days had experienced heavy rainfall. The frog started calling at about 1745 hrs on June 6, and kept on calling till the early hours of the next day. It apparently stopped calling at about 0730 hrs, when the first rays of the rising sun reached the spot where it sat. I carefully listened and monitored the call for the next three days and arrived at some statistics.

Every night the frog called continuously for almost 13 hours. The call can be transcribed as *Oo-wak-wak......wak!* The call always started with a short and quick *Oo* followed by quick-repeated *wak*. The sound *wak* was repeated from one to twenty-six times in one go (average=7). The interval between two successive call series was just one or two seconds. On an average, the *wak* call was repeated 102 times per minute during the evening and midnight hours and 83.42 times per minute during the morning hours (average=96). The total number of times the syllable *wak* was uttered throughout the night (about 13 hours) was calculated to be around 78,000. The small creature also kept on calling during the daytime, but intermittently. The estimated day call figure came to around 18,000. Adding this figure to the night figure, it can be plainly stated that the frog uttered the call *wak* 96,000 times in 24 hours!

Considering the small size of the animal, this was quite an extraordinary feat!

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19. RANGE EXTENSION OF *PANGIO GOAENSIS* (CYPRINIFORMES : COBITIDAE) TO THE CHALIYAR DRAINAGE OF KERALA

(With one plate)

The elongate cobitid *Cobitis pangia* Hamilton 1822, described originally from northeastern Bengal, but later recorded also from Myanmar (Day, 1875-78), was placed in *Acanthophthalmus* (van Hasselt 1823) by Gunther (1868:370). A second species from India, was described by Tilak (1973) from a specimen 31.0 mm SL, collected from Colem river, Goa (15° 20' N, 74° 16' E). Subsequently, Menon (1992) in a revision of the Indian Cobitidae, added another species *A. longipinnis* from Kharangpat lake, Manipur, India, bringing the total number of species of *Acanthophthalmus* in India to three. Kottelat (1987), showed that the genus name *Acanthophthalmus* was a junior objective synonym and revived *Pangio* Blyth 1860, for these fishes. In India, the genus has until now been recorded only from northeast Bengal and Goa. Its presence further south in Kerala is of ichthyological significance.

Pangio goaensis (Tilak 1973)
(Figs. 1 & 2)

Acanthophthalmus goaensis Tilak (1972)
Acanthophthalmus goaensis Menon 1992
Pangio goaensis Menon (1993)

Diagnosis: *Pangio goaensis* is distinguished from the other species of *Pangio* known from India in having the dorsal fin origin located between the pelvic and anal fin origins, by the presence of a fringed flap on the outer side of each mental lobe, and by the presence of two longitudinal colour bands on the body (vs. dorsal fin origin above pelvic fin base in *P. longipinnis*; and no fringed flap on outer side of mental lobes or longitudinal colour bands on the body of *P. longipinnis* or *P. pangia*).

Coloration: Ground colour of body (in alcohol) yellowish; two horizontal lateral bands, one along mid-lateral extending beyond eyes and bending to snout tip, one below dorsal running forward and meeting the band of the other side across the snout. A predorsal band which is broken down into spots before dorsal.

Pangio goaensis is so far known only from the holotype, 31.0 mm SL, from Goa. The presence of this species in the drainage of the Chaliyar river, Kerala, extends its range of distribution to the west-flowing rivers of the Southern Western Ghats. There is no significant difference in any of the biometric characters studied except the length of the fins, which are observed to be longer than those described by Tilak (1973), for the holotype; this could be due to the smaller size of our specimens. The caudal fin of our specimens is, however, rounded and not emarginate as in the holotype.

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K. Rema Devi *et al.*: *Pangio goaensis* PLATE 1

Fig.1. Lateral view of *Pangio goaensis,* 19.7 & 17.1 mm SL., F. 4493/ZSI/SRS.

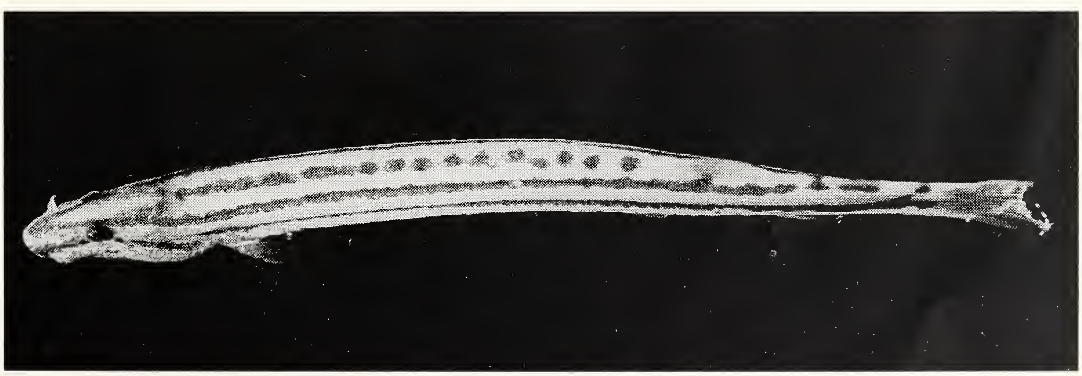

Fig.2. Dorsal view of *Pangio goaensis,* 19.7 mm SL

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20. FISHES OF NAMBIYAR RIVER, KALAKAD-MUNDANTHURAI TIGER RESERVE, TAMIL NADU

Kalakad-Mundanthurai Tiger Reserve (KMTR) is located at the southernmost tip of the Western Ghats. Several streams originate and drain into the major east-flowing perennial river Tamiraparani. Johnsingh and Wickram (1987) reported freshwater fishes from the Kalakad-Mundanthurai Wildlife Sanctuary with a notable exception on the Nambiyar river, a separate river basin with several tributaries in the KMTR. Documentation is needed due to the threats to the river system and fish fauna. The present survey is a study of the fish diversity in the Western Ghats streams under the Western Ghats Biodiversity Programme.

Nambiyar river is one of the east-flowing rivers in Nanguneri taluka, Tirunelveli dist., Tamil Nadu, forming a minor river basin. This river originates in the eastern slopes of the Western Ghats at 1650 m above msl in the Kalakad Reserve Forest. It is drained by two major tributaries viz., Thamarayar and Parattaiyar. The 48 km long river flows a distance of 9.6 km in the hilly regions before it confluences with the Bay of Bengal. The river has nine anicuts/weirs (check dams) and 40 wetlands. Due to multiple impoundments along its course, it reaches the Bay of Bengal only during monsoon.

Fishes were collected from two sites, covering upstream and downstream regions in Nambiyar river, using various mesh sizes of monofilamentous gill nets, drag nets and scoop nets. The colour spots and other. important characters of the catch were noted, and the specimens preserved in 10% formalin. In larger specimens, 2-5 ml formalin was injected into the abdomen.

In Nambiyar river, 14 species of 2 orders, 8 families and 13 genera were recorded (Table 1). All the species are known from the Western Ghats of South India (Talwar & Jhingran 1991), however, this is the first report on these fishes from the Nambiyar river system. Among the species caught, the air-breathing *Channa* sp. and

TABLE 1
FISH SPECIES AND THEIR CURRENT STATUS IN NAMBIYAR RIVER

		Fish Species	Current Status
I		Order: Cypriniformes	
i.		Family: Cyprinidae	
a		Genus: *Puntius*	
	1.	*Puntius arenatus* (Day)	Not assessed
	2.	*Puntius chola* (Ham.-Buch.)	Vulnerable
b		Genus: *Amblypharyngodon*	
	3.	*Amblypharyngodon microlepis* (Bleeker)	Not assessed
c		Genus: *Danio*	
	4.	*Danio aequipinnatus* (McClelland)	Low risk, near threatened
d		Genus: *Esomus*	
		Esomus thermoicos (Val.)	Not assessed
e		Genus: *Parluciosoma*	
	6.	*Parluciosoma daniconius* (Ham.-Buch.)	Low risk, near threatened
f		Genus: *Garra*	
	7.	*Garra mullya* (Sykes)	Not assessed
ii		Family: Parapsilorhynchidae	Not assessed
g		Genus: *Nemacheilus*	
	8.	*Nemacheilus triangularis* Day	Low risk, least concern
iii.		Family: Cobitidae	
h		Genus: *Lepidocephalus*	
	9.	*Lepidocephalus thermalis* (Val.)	Not assessed
II		Order: Siluriformes	
iv		Family: Bagridae	
i.		Genus: *Mystus*	
	10.	*Mystus armatus* (Day)	Not assessed
v		Family: Aplocheilidae	
j		Genus: *Aplocheilus*	
	11.	*Aplocheilus lineatus*	Not assessed
vi		Family: Cichlidae	
k		Genus: *Oreochromis*	
	12.	*Oreochromis mossambica* (Peters)	Not assessed
vii		Family: Belontiidae	
l		Genus: *Macropodus*	
	13.	*Macropodus cupanus* (Val.)	Not assessed
viii		Family: Channidae	
m		Genus: *Channa*	
	14.	*Channa punctatus* (Bloch)	Low risk, near threatened

catfish *Mystus armatus* are of major importance for fishery. Other small species are of minor interest. Introduction of *Oreochromis* is a threat to the native fauna.

The Nambiyar river is disturbed by anthropogenic activity, due to the pilgrim sites upstream, which is highly disturbed by the washing, bathing and other activities of the pilgrims and tourists. The headwater stream has midstory and overstory trees, but the lowland riparian vegetation has been altered by agricultural farms. Agricultural effluent is a major threat to the ecosystem in the lowland. Diversion of small streams for irrigation upstream is also a major threat to the stream habitats and fish fauna of the Nambiyar river.

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21. A PROFILE OF THE FOOD AND FEEDING OF HILLSTREAM TELEOSTS OF GARHWAL HIMALAYAS

Hillstreams of the Garhwal Himalayas are either glacier- and snow-fed (mostly larger and perennial streams such as Yamuna, Tons, Bhagirathi, Alaknanda, Mandakini, Pindar), nonglacier- and/or spring-rain-fed. Almost all the hillstreams of the Garhwal Hills (especially in their meta- and hyporhithron zones) harbour abundant and diverse ichthyofauna, reflecting a diversity of habitat, food and location of migratory routes.

Occupied Habitats

The category of hillstream fishes, based on feeding habits, are:

1. Surface feeders, e.g. *Barilius bendelisis*, *B. vagra*, *B. barila*, *B. barna*, *Xenentodon cancila* and *Esomus dauricus*.

2. Column feeders, e.g. *Schizothoraichthys progastus*, *Puntius chola*, *P. sophore* and *P. sarana*, and

3. Bottom feeders, e.g. *Schizothorax plagiostomus*, *S. richardsonii*, *Garra* spp., *Crossocheilus latius latius*, *Glyptothorax* spp. and *Pseudecheneis sulcatus*.

There is no convincing method of differentiating the feeding sites from non-feeding sites. It may be indirectly inferred from observations on gut contents and seasonal variations of feeding.

Das and Moitral (1963, 1965) classified the feeding habits of fishes from the Central Himalayan streams (including Garhwal Himalaya) as: i. Herbivorous (75% of food is plant material), ii. Omnivorous (plant and animal material approximately 50% each), and iii. Carnivorous (animal material constitutes over 75%). Later, two categories were added, Herbi-omnivorous (greater amount of plant material) and Carni-omnivorous (a greater amount of animal material). Twenty-seven teleost species from Garhwal Himalaya have been classified according to their feeding habits (1993) (Table 1).

According to to Nikolsky's (1963) scheme, based on variation in the type of food consumed, most fishes from Garhwal rivers (especially the 27 reviewed in Table 1) are either euryphagic (take a wide variety of food items) or stenophagic (feed on few types of food) except a few, viz. *Pseudecheneis sulcatus*, *Glyptothorax pectinopterus*, *G. conirostris*, *G. telchitta* which feed only on a single category of food, e.g. larvae and nymphs of aquatic insects.

Peculiar features and adaptations for food selection

The basic morphology of the feeding apparatus, common to all teleosts, differs in form according to the species, and is adapted to a particular mode of feeding (Larkin 1979). The primary feeding adaptations of herbivore fish are structural in nature. Food capture by carnivores generally requires more elaborate techniques, as potential prey has its own behavioural and structural arrangements for avoiding capture.

Hillstream fishes of Garhwal region live under ecological conditions that may be stressful and less favourable for optimal feeding. These fishes have evolved numerous adaptations to this environment, some of which affect their food gathering and feeding:

TABLE 1
FEEDING HABITS AND BASIC FOODS OF SOME HILLSTREAM TELEOSTS

Feeding habits	Fish species	Basic foods	Special remarks
Herbivorous	*Schizothorax richardsonii*	algae, diatoms and surface scraps of the bottom	bottom feeder benthophagous and detritophagous
	S. plagiostomus	"	"
	S. sinuatus	"	"
	Crossocheilus latius latius	"	"
	Garra gotyla gotyla	"	"
	G. lamta	"	"
	Labeo dyocheilus	diatoms and algae	bottom feeder
	L. dero	"	"
Herbi-omnivorous	*Puntius chilinoides*	diatoms, algae, aquatic weeds insects and their larvae	"
	Tor spp.	"	"
Omnivorous	*Puntius ticto*	-	-
	P. chola	-	-
	Chagunius chagunio	-	-
	Barilius bendelisis	-	-
	B. barila	-	-
	B. barna	-	-
Carni-omnivorous	*Schizothoraichthys progastus*	insect larvae, crustaceans pre-dominant but aquatic weeds and algae also present	-
	B. vagra	"	-
	Noemecheilus multifasciatus	"	-
	N. rupicola	"	-
	N. montanus	"	-
Carnivorous	*Pseudecheneis sulcatus*	aquatic insects, their larvae and nymphs	bottom feeder and monophagic
	Glyptothorax telchitta	"	"
	G. pectinopterus	"	"
	G. conirostrus	"	"
	B. bola	-	-
	Mastacembelus armatus	insects, larvae and nymphs; small sized fishes also present	predator

a) The mouth opening in the bottom feeders, bottom scrapers, burrowers and mud suckers (*Garra gotyla gotyla*, *G. lamta*, *Schizothorax plagiostomus*, *S. richardsonii*, *Crossocheilus latius latius*, *Pseudecheneis sulcatus*, *Glyptothorax* spp.) is wide and situated ventrally and subventrally instead of being terminal as in other teleosts. A hard scraping plate in the lower jaw, posterior to the mouth opening, helps in scraping the detritus. In *Tor tor* and *Schizothoraichthys progastus*, the mouth is suctorial and funnel-shaped, formed by the eversion and modification of lips. *Mastacembelus armatus* has an upperjaw and lip longer than the lower one, a well developed dental battery in both jaws, suitable for predation.

b) Location of food depends on the sensory capabilities, of the fish. Vision is important in species with large prominent eyes, while the non-visual senses are important in fishes with reduced visual capability (Aleev 1969). This is common among fishes living at the bottom or in conditions of reduced light. Accordingly, the fish species are described as sight feeder (using visual stimuli while gathering food) and nose feeders (using olfactory cues for feeding). The strictly surface and column feeder carnivores (predators, piscivore and larvivore), and herbivorous fishes are sight feeders, whereas, bottom feeders

(detritophagous and mud suckers) are nose feeders (Table I.)

Based on the observation of the major gut contents and food preference under normal and, abnormal situations, the various food items may be described as:

1. Basic food - major part of gut contents throughout the year.
2. Secondary food - frequent in gut contents, but lesser than basic foods.
3. Obligatory food - forced to take under stress and food scarcity.
4. Incidental food - of rare occurrence.

Reduction in availability of 'preferred' prey resources

Degradation of favourable feeding sites leads to adverse qualitative and quantitative impacts on the growth of planktonic and benthic communities. This causes in turn serious disruption of the food chain and the energy cycle in the early phases of the life cycle of omnivorous, herbi-omnivorous, carni-omnivorous and carnivorous fish species. Food availability, the nature of feeding grounds and stimuli-feeding responses are less compatible with the adaptations/specialisations for torrential rapids in the hillstreams, particularly in case of bottom dwellers and feeders; the water current has played a significant role in their evolution.

Alterations in water quality are also brought about by the addition of silt, explosives, large rocks (a result of dam/barrage construction) as well as irrational fishing methods.

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22. A SUPPLEMENTARY LIST OF THE HOST-PLANTS OF INDIAN LEPIDOPTERA

Indian Lepidoptera are comparatively well known. The early stages and biology of all species of economic importance are known, but little emphasis has been placed on the remaining species. These constitute the vast majority and are of significance in bio-diversity studies.

The opportunistic rearing of eggs from gravid females and larvae discovered in the field

over a period of several years resulted in the discovery of the following, hitherto unreported, hostplants. This work was carried out in the Kumaon Himalaya in northern India, at an elevation of 1500 m above msl.

The taxonomy of several groups of moths is in need of review. In cases such as the *Spilarctia* Butler species of the *sagittifera* Moore group (Arctiidae), and what was previously the *Dasychira* Steph. genus (Lymantridae), we have not assigned specific status.

Rosa sp., mentioned as the hostplant of *Eterusia leptalina* Kollar, *Dasychira inclusa* Walker and *Spilarctia multiguttata* Walker, are hybrid tea roses rather than good species. In some cases, hostplants accepted in one part of the insect's range are refused in other parts. Thus, freshly emerged larvae of *Ambulyx liturata* Butler (Sphingidae) did not accept *Quercus leucotrichophora* A. Camus and *Q. floribunda* Lindley ex A. Camus (Fagaceae) in Kumaon, although it has been bred on *Quercus* Linn. in China by Mell (Bell and Scott 1937).

The preference of most local Arctiinae for *Pouzolzia zeylanica* (Linn.) Bennet & Brown, *Setaria megaphylla* (Steud.) Dur. & Schinz, and *Plantago major* Linn. is of interest. Many well known European Arctiinae are extremely polyphagous, the larvae having accepted, in addition to the known hostplants, such diverse items as potatoes, apples and even bread! The same cannot be said of the Himalayan species, except perhaps members of the *Spilarctia casigneta* group. We did not get the opportunity to try *Setaria megaphylla* on *Estigmene imbuta* Walker, but there seems a likelihood that it will accept it as readily as *Pouzolzia* Gaud. It, however, did not accept *Plantago major*.

Gardner (quoted by Sevastopulo 1949) notes that the larvae of *Polytela gloriosae* Fabr. (Noctuidae) feed on Liliaceae and Amaryllidaceae, species of *Zephyranthes* Herb. being specially favoured. In our experience, they much prefer *Gloriosa superba* Linn. to *Zephyranthes carinata* Herb., for they will not touch the latter so long as even a stem of the former is available. We have also bred them on *Zephyranthes* Herb.

All the following bred specimens are in our collection. We have followed Barlow (1982) in the arrangement of moth families.

Lepidoptera Species	Host Plant Species
Family: Zygaenidae	
Tripanophora semihyalina Kollar	*Camellia sinensis* (Linn.) Kuntze (Theaceae) *Wisteria sinensis* (Sims.) DC (Leguminosae) *Pelargonium* L'Herit (Geraniaceae)
Eterusia leptalina Kollar	*Pyrus communis* Linn. (Rosaceae) *Rosa* sp. (Rosaceae)
Agalope bifasciata Hope	*Crataegus crenulata* G. Koch (Rosaceae)
Family: Limacodidae	
Darna ?cotesi Swinhoe	*Cyperus paniceus* (Rottb.) Boeck. (Cyperaceae)
Family: Bombycidae	
Bombyx huttoni Westwood	*Morus nigra* Linn. (Moraceae)
Family: Sphingidae	
Dolbina inexacta Walker	*Olea glandulifera* Wall. ex DC (Oleaceae)
Family: Notodontidae	
Chadisra bipars Walker	*Grewia optiva* J.R. Drummond ex Burret (Tiliaceae)
Family: Arctiidae	
Spilarctia sp. of the *sagittifera* group	*Dioscorea bulbifera* Linn. (Dioscoreaceae) *Cuscuta reflexa* Roxb. (Convolvulaceae) *Strobilanthes dalhousianus* (Nees) C.B. Clarke (Acanthaceae) *Plantago major* Linn. (Plantaginaceae)

Lepidoptera Species	Host Plant Species
	Pouzolzia zeylanica (Linn.) Bennet & Brown (Urticaceae) *Setaria megaphylla* (Steud.) Dur. & Schinz (Graminae)
Spilarctia multiguttata Walker	*Rosa* sp. (Rosaceae) *Dioscorea bulbifera* Linn. (Dioscoreaceae)
Estigmene imbuta Walker	*Pouzolzia zeylanica* (Linn.) Bennet & Brown (Urticaceae)
Estigmene quadriramosa Kollar	*Plantago major* Linn. (Plantaginaceae) *Taraxacum* sp. (Compositae) *Pouzolzia zeylanica* (Linn.) Bennet & Brown (Urticaceae)
Pericallia galactina von. d. Hoev	*Pouzolzia zeylanica* (Linn.) Bennet & Brown (Urticaceae) *Setaria megaphylla* (Steud.) Dur. & Schinz (Graminae)
Pericallia imperialis Kollar	*Plantago major* Linn. (Plantaginaceae) *Pouzolzia zeylanica* (Linn.) Bennet & Brown (Urticaceae) *Setaria megaphylla* (Steud.) Dur. & Schinz (Graminae)
Callimorpha plagiata Walker	*Pouzolzia zeylanica* (Linn.) Bennet & Brown (Urticaceae)
Macrobrochus gigas Walker	Lichens
Family: Lymantridae	
Euproctis latifascia Walker	*Quercus leucotrichophora* A. Camus (Fagaceae)
Euproctis plagiata Walker	*Glochidion velutinum* Wight. (Euphorbiaceae)

Lepidoptera Species	Host Plant Species
Euproctis anguligera Butler	*Glochidion velutinum* Wight. (Euphorbiaceae)
Dasychira inclusa Walker	*Quisqualis indica* Linn. (Combretaceae) *Rosa* sp. (Rosaceae)
Dasychira sp.	*Bauhinia vareigata* Linn. (Leguminosae)
Ilema nigritula Walker	*Dioscorea bulbifera* Linn. (Dioscoreaceae)
Family: Agaristidae	
Episteme adulatrix Kollar	*Dioscorea bulbifera* Linn. (Dioscoreaceae)
Family: Noctuidae	
Cocytodes coerulea Guenee	*Bohemeria platyphylla* D. Don (Urticaceae)
Thysanoplusia orichalcea Fabricius	*Lepidium virginicum* Linn. (Cruciferae)
Polytela gloriosae Fabricius	*Gloriosa superba* Linn. (Liliaceae) preferred over *Zephyranthes carinata* Herbet (Amaryllidaceae)
Family: Epiplemidae	
Epiplema reticulata Moore	*Jasminum dispermum* Wallich (Oleaceae)
Family: Pyralidae	
Agathodes ostentalis Huebner	*Erythrina suberosa* Roxb. (Leguminosae)
Family: Pieridae	
Pontia daplidice Linne	*Lepidium virginicum* Linn. (Cruciferae)
Artogeia canidia Sparrman	*Lepidium virginicum* Linn. (Cruciferae)
Family: Nymphalidae	
Symbrenthia lilaea Hewitson	*Bohemeria platyphylla* D. Don (Urticaceae)
Precis iphita Cramer	*Aechmanthera tomentosa* Nees (Acanthaceae)
Pareba issoria Huebner	*Debregeasia longifolia* (Burm. f.) Wedd. (Urticaceae)

ACKNOWLEDGEMENTS

We thank Professor Y.P.S. Pangtey and Dr. B.S. Kalakoti, Department of Botany, Th. D.S.B. College, Nainital, who kindly identified some of the plants, and Dr. Poonam Mehrotra of the Department of Ecology of the same institution for her kind help with the bibliography.

October 27, 1999

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23. ON THE PREDATION OF THE GIANT REDEYE *GANGARA THYRSIS* (FABRICIUS) (FAMILY : HESPERIIDAE; ORDER : LEPIDOPTERA)

The Giant Redeye *Gangara thyrsis* Family Hesperiidae is not an uncommon butterfly in Bangalore. It is often seen in gardens around its food plants — *Areca lutens, Cocos nucifera* and other palms.

Observations on the predators of the Giant Redeye were made on nine *Areca lutens* plants ranging in height from 1-4 m, and frequented by these insects. It was observed that the bonnet macaque (*Macaca radiata*) and the house crow (*Corvus splendens*) fed on the larvae and pupae of the Giant Redeye.

One individual of a troop of bonnet macaques which visited the premises where observations were made, systematically searched all the palms for larvae and pupae. The macaque searched the leaves rolled up by the larvae, opened them, and ate the larvae (which have long, loosely attached, white thread-like outgrowths amidst which are red spots).

Similarly, the macaque opened the tubes made of palm fronds which conceal the pupae and ate the pupae.

A house crow which visited the premises seemed to have noticed a pupa of the Giant Redeye. It gave up its efforts to procure the pupa as it was unable to balance itself on the slender palm fronds. A good half hour had elapsed before the bird returned and perched on the neighbouring *Colocasia* sp.(?) growing amidst the palms. From the new perch, it successfully ripped open the tube and swallowed the pupa whole.

These are probably new records of predators of the Giant Redeye.

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24. MATING BEHAVIOUR OF THE COMMON MORMON *PAPILIO POLYTES* (FAMILY: PAPILIONIDAE)

During February 1998, I was studying the metamorphosis of different species of Papilionidae and Nymphalidae in my home laboratory. The Common Mormon (*Papilio polytes*) was one of the species reared successfully. After a pupal period of ten days, a female Common Mormon emerged from its chrysalis at about 0900 hrs. The Common

Mormon is known to exhibit polymorphism, having three female forms. So I observed it carefully and found that it belonged to the *stichius* form which resembles the Common Rose (*Pachliopta aristolochiae*). After spreading its shrunken and wet wings, I shifted the butterfly to dry its wings on to a lemon tree from which the caterpillar was collected. I kept watching continuously for about 30 minutes and took some photographs. During this time I noticed a male Common Mormon flying around the lemon tree. I took detailed notes and left the site.

I visited the site again after 20 minutes and was astonished to find the newly emerged butterfly mating with the mature male Mormon. It was very interesting that the female Mormon had not even changed its position from where I had placed it initially. The marginal wing scales of the male Mormon were somewhat damaged and wing edges ruptured, indicating the extremity of its lifespan.

The male and female were in the clasped posture for another 90 minutes, with both their wings spread. The male was inverted, suspended from the copulatory organ of the female. The hind wing of the female remained on the upper side, overlapping the male's wing. A white droplet of spermatozoa was observed on the wingbase of the male Mormon, perhaps splashed during the ejaculation. It was most surprising that the female became involved in mating immediately upon emergence, even prior to its first flight.

ACKNOWLEDGEMENTS

I thank my family for support and help in the rearing of butterflies. I especially thank Mr. Samarjit Paul for valuable information and help in specimen collection, and Md. Latif Hussain, for use of his computer.

May 20, 1999

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25. MYCOPHAGOUS ARTHROPODS FROM THE ANDAMAN ISLANDS

The native fungi and their associated arthropods are both very poorly known from the Andaman and Nicobar Islands. To study the nature of fungal-arthropod interactions we have been documenting the arthropod fauna of the fungi of these islands.

The arthropods so far collected on fungi from the Islands are represented by Coleoptera (including mycophagous staphy-linids and tenebrionids) and a couple of Acarina. The oyster mushroom *Pleurotus sajor-caju* is attacked by *Scaphisoma* sp. (Coleoptera) in the cropping chamber, when this mushroom is cultured indoors.

List of Mycophagous arthropods from the Andaman Islands are as follows:

Insecta
- Coleoptera
  - Ciidae — *Cis* spp.*
  - Erotylidae — *Spondotriplax andamana* Arrow
  - Scaphidiidae — *Scaphisoma* sp.
  - Staphylinidae — *Gyrophaena* sp.
  - Tenebrionidae (Toxicinae) — *Cryphaeus* sp.

Acarina
- Mesostigmata
  - Uropodidae — *Cyllibula?bordagei* (Oudemans)
  - Oribatada (=Cryptostigmata)
    - Parakalummidae — Genus et sp. indet.

*Four species, presently not identified, were recorded.

ACKNOWLEDGEMENTS

We thank Dr. A.K. Bandyopadhyay, Director, C.A.R.I. for encouragement and Drs. R.G. Booth and D. MacFarlane of the International Institute of Entomology, London, for identification.

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26. ON *DAPHNIOPSIS TIBETANA* SARS, 1903, (CLADOCERA) COLLECTED FROM A HIGH ALTITUDE HIMALAYAN LAKE, INDIA

(*With seven text-figures*)

Four species of the genus *Daphniopsis* have so far been described, viz. *D. pusilla*, *D. studeri*, *D. tibetana* all by Sars (1903) and *D. australis* by Sergeev and Williams (1985). All the four species occur in saline water, among which *D. tibetana* is found in high altitude Himalayan saline lakes in India, Nepal, Tibet and Mongolia. After the original description of *D. tibetana* by Sars (1903) from Tibet, Brehm and Woltereck (1939) recorded the same species as *Daphnia tibetana* from Panggong Tso in Ladakh. The present report is a record of this species after a gap of five decades. A detailed description, and new morphological characters have been given, based on a few samples collected from Panggong Tso Lake.

A few samples collected during one of the regular trips to high altitude Himalayan lakes by the Zoological Survey of India, Solan, at Panggong Tso lake on August 23, 1998, were sent to the author for identification. The sample consists of thousands of adult female *Daphniopsis tibetana*, as well as *Cyclops ladacanus*(?) and *Gammarus pulex*(?). The materials used in this study include mature females as well as different pre-adult instars sorted from the collections. The lake Panggong Tso is in the Ladakh district of the western Himalayan region, at an altitude of 4241 m. It is an oligotrophic saline lake (pH 9.35). Other physico-chemical parameters were not recorded due to bad weather conditions.

DESCRIPTION

Daphniopsis tibetana Sars 1903

Daphniopsis tibetana Sars 1903. Acad. Asci. St. Petersb. 8 p. 171.

Daphniopsis tibetana Brehm & Woltereck, 1939. Int. Rev. ges. Hydrobiol. 1-19.

Female: Body size 2.62 mm; Body width 1.65 mm. Head wide and depressed, slightly produced near eye and ventral edge slightly concave. Rostrum prominent and blunt. Fornix extending in front and evenly arched. Eye moderately large, irregularly shaped, ocellus rounded and relatively large.

Carapace without dorsal carina or a posterior spine and not denticulate. Body slightly compressed and oval, dorsal and ventral margins evenly arched (Fig. 1). Postero-ventral margin with numerous submarginal spines. In adult females, carapace slightly larger than wide. Antennules small, immovable, not projecting beyond rostrum, with terminal sensory papillae and subterminal seta. Antennae large, setal formula (0-0-1-3/1-1-3). Hepatic caeca large and coiled as in other daphnids. Trunk limb 2 (Figs. 2-6): external branch of endopodite bearing three slightly chitinised, subequal setae (Figs. 2, 6) gnathobase 18 setae, (Fig. 2) with a second seta different in structure (Figs. 3, 4) from the sensory papilla of gnathobase (Fig. 5). Postabdomen (Fig. 7) tapering distally, dorsal margin sinuate with 10-12 anal denticles. Ventral margin of the

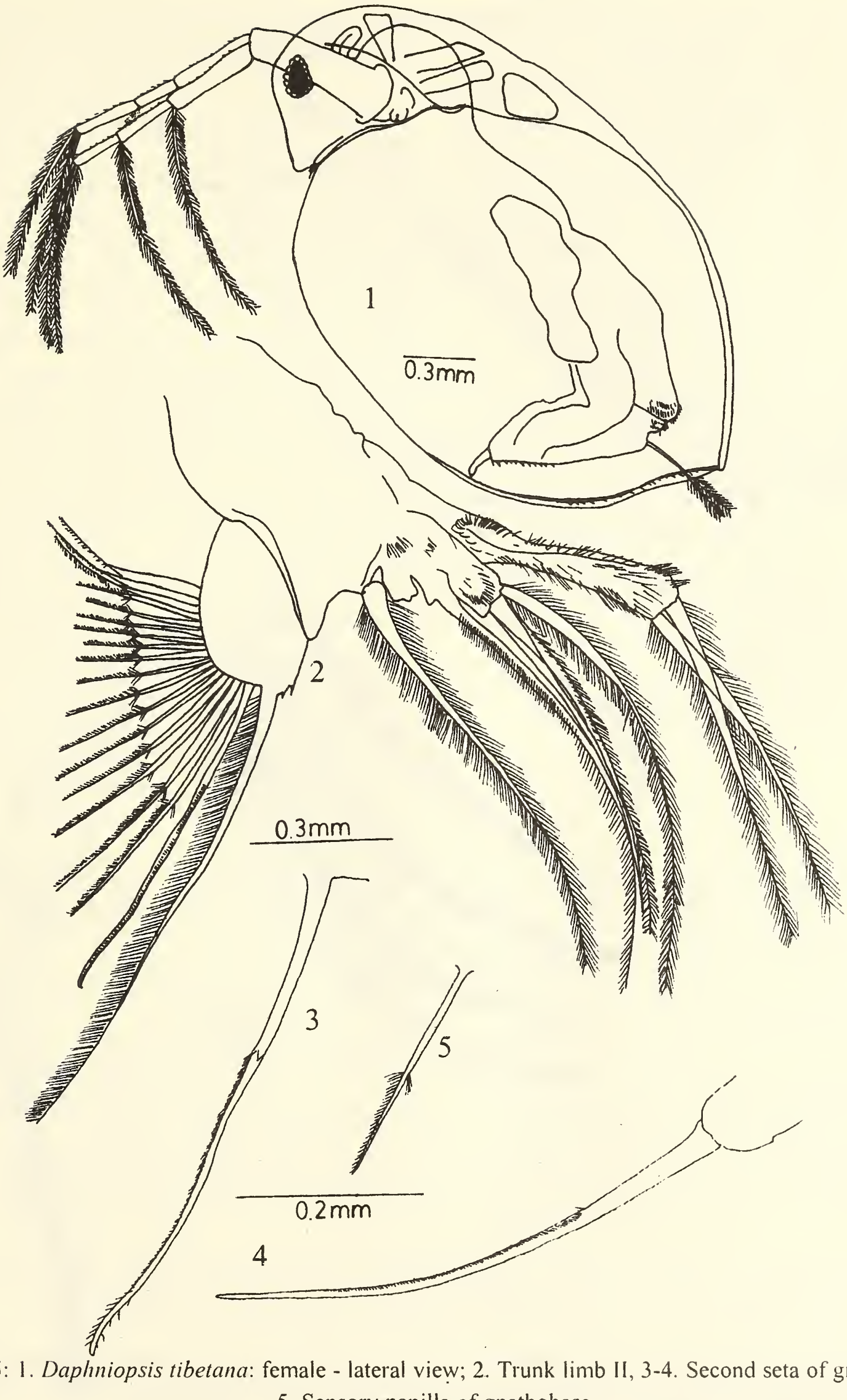

Fig. 1-5: 1. *Daphniopsis tibetana*: female - lateral view; 2. Trunk limb II, 3-4. Second seta of gnathobase, 5. Sensory papilla of gnathobase.

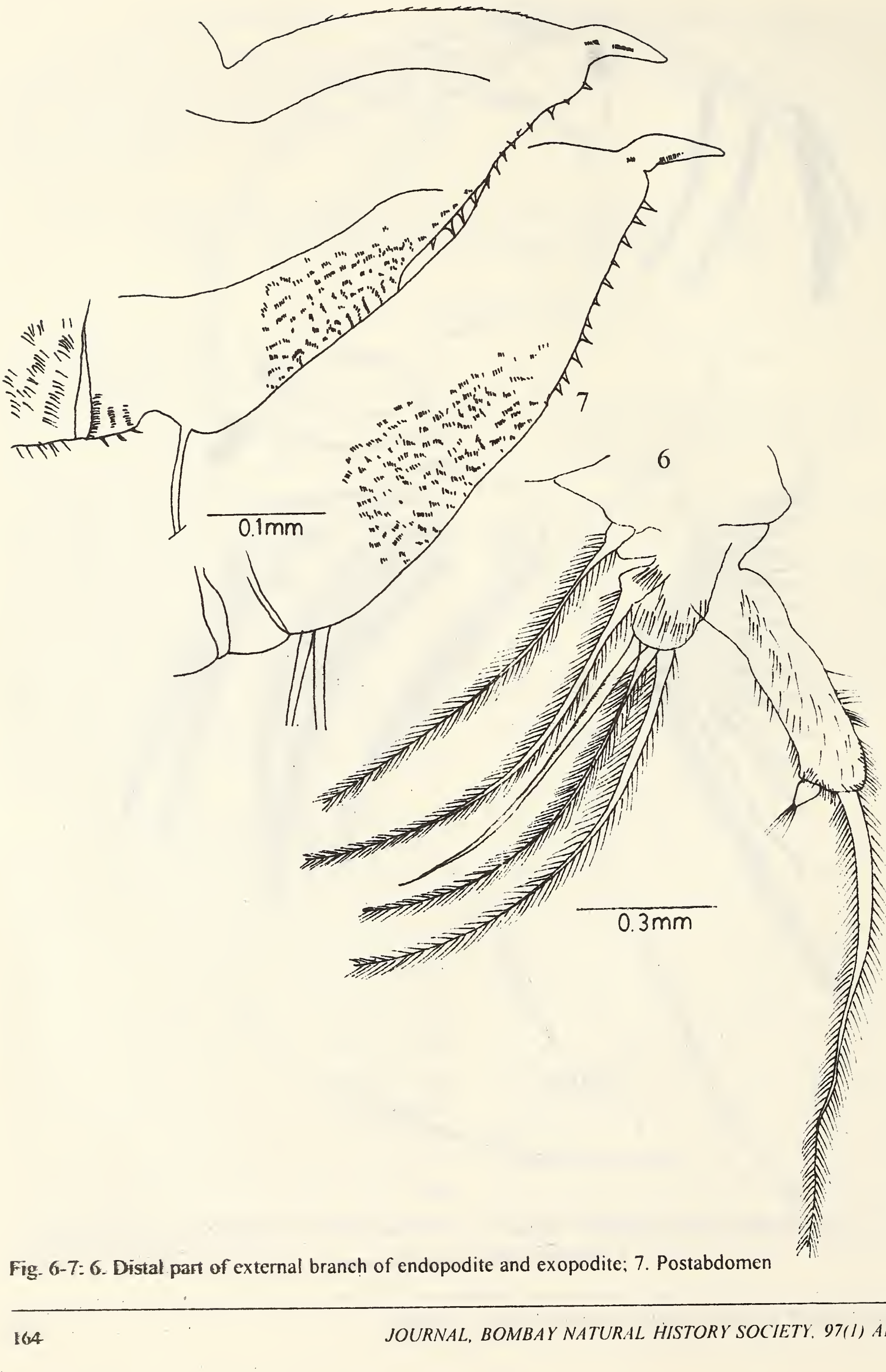

Fig. 6-7: 6. Distal part of external branch of endopodite and exopodite; 7. Postabdomen

postabdomen with a series of small spines. Claws with proximal and middle combs of lateral setae. Abdominal process long.

Males: Not found in the present study.

Remarks: Michael & Sharma (1988), while compiling the Fauna of India, Cladocera, described *Daphniopsis tibetana* from the literature only since no material was available to them. However, Chiang and Du (1979) described *D. tibetana* from China with a maximum adult size of 2.30-2.90 mm, which is slightly larger than the present record of 2.62 mm. Sergeev and Williams (1985) separated *D. australis,* a new species, from *D. pusilla* in Australian salt lakes based on the trunk limb morphology, with a body size of 1.82 ± 0.36 mm, which is relatively smaller than *D. tibetana* in this sturdy. Loffler (1969) studied the general limnology of 24 high altitude lakes of Khumbu area, Nepal and recorded three species of Cladocera among which *D. tibetana* is one. A decade after the visit of Loffler, Swar and Fernando (1979) recorded *D. tibetana* along with 22 other species of Cladocera from Pokhara Valley, Nepal. However, Dumont and Van der Velde (1977) who surveyed the same area, could not collect *D. tibetana* from Nepal. The ephippial morphological studies conducted by Kokkinn and Williams (1987) found six morphotypes among the species of *Daphniopsis* in the salt lakes of Australia. However, in India no such studies have been undertaken due to the remoteness of the habitat where *D. tibetana* is found.

ACKNOWLEDGEMENTS

I thank Dr. J.R.B. Alfred, Director Zoological Survey of India for sending the lake collections to me for identification and facilities to conduct this study. I thank Shri A. Sivakumar, Technical Assistant, ICMAM Project, MBS. ZSI for typing the manuscript.

August 6, 1998

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27. *INDIGOFERA MYSORENSIS* ROTTLER EX DC. (LEGUMINOSAE : PAPILIONOIDEAE) — AN ENDEMIC SPECIES OF PENINSULAR INDIA FROM WEST BENGAL

During a plant collection tour in Uttar Dinajpur District, West Bengal, specimens of a branched, erect, sticky, villous undershrub were collected from the deforested dry sandy areas of

Hemtabad Forest Beat in Raiganj subdivision. These specimens were identified as *Indigofera mysorensis* Rottler ex DC., a species that has hitherto been considered as endemic to the Deccan peninsula. Its known northern limit has been the Tirupati Hills of Andhra Pradesh. It has not been collected from Orissa and southern West Bengal. This species is recorded here for the first time from a disjunct locality i.e. Hemtabad forest in Uttar Dinajpur, West Bengal.

Indigofera mysorensis Rottler ex DC., Prodr. 2: 222. 1825; Baker in Hook. *f.* Fl. Brit. India 2: 102. 1876; Gamble, Fl. Pres. Madras 1: 313. 1918; Sanjappa in Fasc. Fl. India 21: 100, fig. 39. - 1995.

Type: Ind. Orient., Mysore, Rottler s.n., Herb. De Candolle 2: 222 (G - DC. microf.!).

Fl.: Sept.-Dec.; **Fr.**: Dec.-March.

Distribution: Western Ghats (Nilgiri hills upto 1200 m); Chittoor, Cuddapah, Nellore and Kurnool districts of Andhra Pradesh; Bangalore, Mysore, Mandya districts of Karnataka and Uttar Dinajpur district of West Bengal.

Field notes: Bushy, viscid, undershrub; stem and branches pinkish; apices of leaflets and calyx with dark brown sticky glands, and leaves often stained with dark brown liquid.

Specimen examined: West Bengal: Uttar Dinajpur, Hemtabad Forest Beat, Raiganj Subdivision; 25.i.1997; S. Mitra 2887 A - C (CAL)

February 3, 1999

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28. RANGE EXTENSION OF *NEPENTHES KHASIANA* IN THE JAINTIA HILLS, MEGHALAYA

(*With one text-figure*)

The pitcher plant belongs to an interesting group of insectivorous herbs. Of the two genera, only one, i.e., *Nepenthes* is represented in India, and that too by one species *N. khasiana* Hk. f. which is confined to Meghalaya. In Meghalaya, it occurs only in the high rainfall southern facies of the plateau from 100-1500 m above msl, affecting both tropical evergreen and sub-tropical wet hill forest, often with patches of grass. So far, specimens have been collected from a few localities in the South Garo Hills and Jaintia Hills districts (Rodgers and Gupta, 1989). The pattern of distribution suggests that it occurs in East and West Khasi Hills district also. Maheskhola shown in East Khasi Hills by Rodgers and Gupta (1989) is actually on the South Garo Hills-West Khasi Hills border. In Jaintia Hills, it has been recorded from Jowai and Jarain. So far, Jowai formed the easternmost as well as northernmost recorded locality (25° 27' N, 92° 12' E). while Baghmara in South Garo Hills forms the westernmost (90° 40' E) although there are some reports from farther west also (90° 25' E).

I report here a new locality in Jaintia Hills where I observed and photographed *N. khasiana*. On June 11, 1998 while driving from Guwahati to Silchar via Meghalaya, I noticed *N. khasiana* in a small area between Khlieriat and Umtra, 9 km from the former and 2 km from the latter, on the left side of National Highway 44 while coming from Khlieriat (25° 20' N, 92° 25' E) (Fig. 1). The plants were mostly on a steep slope alongside the main road. Among other notable plants was the bamboo orchid *Arundina graminifolia*. The elevation of the site is 1100 m above msl. Besides being a new locality, it is also an extension of the eastern limit. A cursory

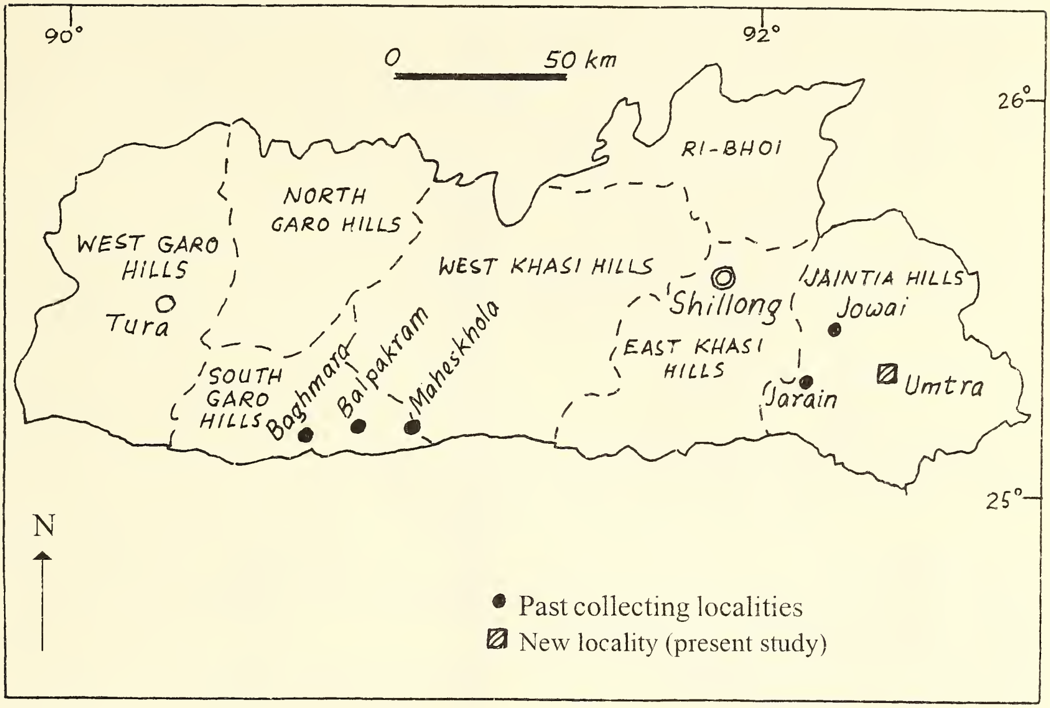

Fig. 1: Map of Meghalaya showing the localities of *N. khasiana*

look indicated the presence of more than 30 pitcher plants on the roadside, and more must have been there.

The Divisional Forest Officer (Wildlife), Jaintia Hills has already been approached for preserving the area as a 'Sanctuary'. Perhaps this is the only known site of pitcher plants alongside a busy National Highway and there is potential for more visitors than in the Baghmara and Jarain Pitcher Plant Sanctuaries. It is hoped that this will help conservation by generating more interest in this rare plant.

Nov. 11, 1998 ANWARUDDIN CHOUDHURY
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REFERENCE

RODGERS, W.A. & S. GUPTA (1989): The Pitcher Plant (*Nepenthes khasiana* Hk. f.) Sanctuary of Jaintia Hills, Meghalaya: lessons for conservation. *J. Bombay nat. Hist. Soc. 86*: 17-21.

29. *SCLERIA LAXA* R. BR. (CYPERACEAE) — A NEW RECORD FOR INDIA FROM NICOBAR ISLANDS

(*With one text-figure*)

During a survey of the grasslands of Nancowry group of islands, I located a scanty population of an interesting sedge, growing amidst tall grasses and forbs along the banks of water-courses which turned out to be *Scleria laxa* R. Br., a species not recorded so far from the Indian region.

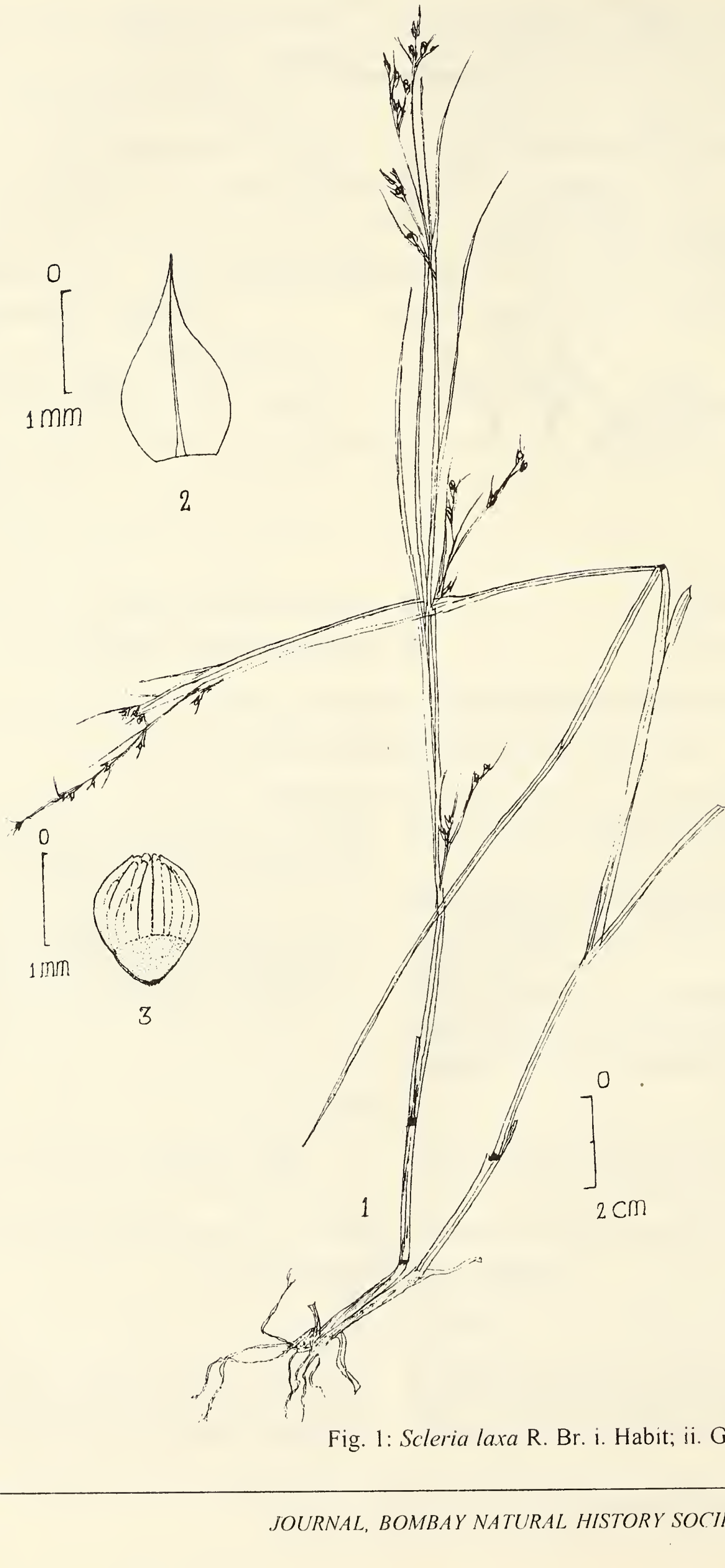

Fig. 1: *Scleria laxa* R. Br. i. Habit; ii. Glume; iii. Nut.

The genus *Scleria* Berg. holds over 200 species, of which about 21 species occur in mainland India (Santapau and Henry, 1994) and 10 in the Andaman-Nicobar Islands. *S. laxa* R. Br. is a remarkable species with very restricted distribution in Queensland, Torres Strait in Malesia and South New Guinea. The present collection from Teressa Is. in the Nancowry group is of much phytogeographic interest. The Nancowry group of islands, situated in the Nicobar district, between 7° 50'-8° 10' N lat. and 93° 30'-93° 40' E long., consists of 8 to 9 far-flung islands with hills, ridges, dense forest and grassland. A striking feature of the plant cover here is the presence of large patches of grassland or heaths. The description of this species is already available in Kern (1974), and a brief note along with a line drawing is provided here, based on the recent collection.

Scleria laxa R. Br., Prod. 240.1810; Kern, Fl. Males. 7:748.1974.

Annual. Culm slender, up to 40 cm high. Leaves linear, 1-3 mm wide. Inflorescence paniculate, of 3-4 fascicles. Peduncles slender, lateral ones longer. Glumes ovate, acute. Nuts globose, ivory-white, shining, longitudinally ribbed, tuberculate at apex, 1.0-1.5 mm wide.

Ecology: Grows along the margins of streams, in open grasslands in association with *Phragmites karka* Steud., *Cyperus* spp., etc.

Fl. & Fr.: January-March.

Specimen examined: Nicobar dt.: Nancowry group of islands, Teressa Is., way to Alu rong at 3 km, + 50 m, 23.ii.1997, coll. P.V. Sreekumar 16726 (PBL).

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November 15, 1998

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30. *RHAPHIDOPHORA CALOPHYLLUM* SCHOTT (ARACEAE) — AN ADDITION TO THE FLORA OF THE ANDAMAN & NICOBAR ISLANDS

(*With one text-figure*)

Specimens of the genus *Rhaphidophora* Hassk. in Indian herbaria were studied for a systematic revision of the Indian Araceae. An unidentified specimen collected on the Nicobar Islands was identified as *Rhaphidophora calophyllum*. The identity was later confirmed with the help of the protologue and type. It is reportedly distributed in northeast India, East Himalayas and also regions of Burma (Hooker, 1893). It is recorded here for the Nicobar Islands. A detailed description and an illustration are provided.

Rhaphidophora calophyllum Schott (in Bonplandia 5: 45. 1857, nom.), Prodr. 380. 1860; Engl. In DC., Monogr. Phan. 2: 242. 1879; Furtado in Gard. Bull. Straits Settlem. 8: 150. 1934; A.S. Rao & D.M. Verma in Bull. Bot. Surv., India 18: 31. 1976; Balakr., Fl. Jowai 2: 560. 1983; Karth. *et al.*, Fl. Ind. Enum. Monocot. 3. 1989. Type: Sikkim, 3-5000 ft., without date, *J.D. Hooker s.n.* (K, photo!).

R. lancifolia Schott (in Bonpandia 5: 45. 1857, nom.), Prodr. 380. 1860; Masters in Gard. Chron. 2: 611. 1874; Engl. in DC., Monogr.

Phan. 2: 241. 1879; Hook. f., Fl. Brit. India 6: 545. 1893; Engl. & Krause in Engl., Pflanzenr. IV 23-B: 26. 1908. *R. peepla* Schott, Prodr. 380. 1860; Hook. f., Fl. Brit. India 6: 545. 1893, excl. Wight, Icon. t. 780. 1844, non *Pothos peepla* Roxb., 1832; Engl. & Krause in Engl., Pflanzenr. IV. 23-B: 41. 1908.

Climber; stems 0.6-1.2 cm across, rooting at nodes; petioles 5.5-20 cm long, slender, channelled at base. Leaves 9.2-27 x 2-12 cm, falcately lanceolate or ovate-lanceolate, cuspidately acuminate or caudate at apex, acute or rounded at base, unequal-sided, a little pendent, greenish brown when dry, coriaceous, or faintly coriaceous when young; primary nerves prominent on both surfaces. Peduncle 2-12.5 cm long. Spathe 5-10 x 3-6 cm, ovate-oblong, beaked, thickly coriaceous, green or orange outside, deep red inside. Spadix 3-7.5 cm long, white or green, yellowish on maturity, elongating to 10 cm in fruits. Ovaries *ca* 3 mm across; stigma raised, pulvinate (Fig. 1).

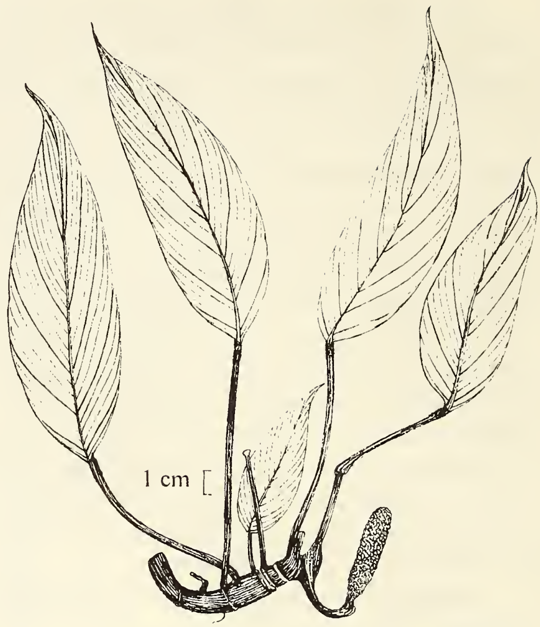

Fig. 1: *Rhaphidophora calophyllum* Schott: Habit

Fl. & Fr.: Sept.-June.

Distribution: INDIA: Uttar Pradesh, West Bengal, Sikkim, Arunachal Pradesh, Assam Manipur, Mizoram, Tripura, Meghalaya, Madhya Pradesh, Andaman & Nicobar Islands. Common.

Extralimital: Bangladesh and Myanmar.

Specimens examined: Andaman & Nicobar Islands (Great Nicobar Island): 31-32 km on Eastwest Road, inland hill forest, 100 m, 14.vi.1977, N. P. Balakrishnan 5757 (CAL). Arunachal Pradesh: Kameng Dist., Bompu hills, 2133 m, 28.iii.1957, G. Panigrahi 6202 (ASSAM). Assam: Nougram Wood, 1500 m, 5.xi.1871, C.B. Clarke 16674 (CAL). Manipur: without precise locality, Dec. 1907, A. Meebold 7026 (CAL). Meghalaya: Khasia hills, 3000-6000 ft., without date, J.D. H(ooker) & T. T(homson) s.n. (Acc. No. 498013; ASSAM); Khasia hills, 3000-6000 ft., without date, J.D. H(ooker) s.n. (Acc. No. 53842; MH); Khasia hills, without date, J.D. H(ooker) 434 (CAL); Khasia hills, 3.xi.1871, C.B. Clarke 15923 (CAL); Khasia hills, 1881-82, G. Watt 5905 (DD); without precise locality, 15.ix.1886, C.B. Clarke 44800; Khasia hills, Oct. 1890, D. Robester s.n. (Acc. No. 497983); without precise locality, 7.ix.1894, G.A. Gammie 486 (CAL); K & J hills, 5200 ft., 18.xii.1915, Kanjilal 6412 (DD); Jowai, 26.v.1956, R.S. Rao 2558; without precise locality, 27.ix.1956, coll. ? 3446 (CAL); K & J hills, Cheerapunji circuit house, Mawsmai falls, 19.xii.1956, coll.? 4817 (ASSAM); without precise locality, 23.i.1957, G.K. Deka 5049, Cheerapunji, Mawsmai forest, 23.ix.1958, G.K. Deka 17171 (CAL); Cheerapunji, 5.v.1961, coll.? 24264; Sorarim, 17.x.1967, A.S. Rao 37786 (ASSAM). Mizoram: Lushai hills, Jungh Valley, 30.iii.1899, A.T. Gage 15 (Acc. No. 498067; ASSAM). Sikkim: Balasan, 9.xi.1895, G. King s.n. (Acc. No. 498000); without precise locality, 30.v.1951, T.T(homson) s.n. (Acc No. 498006; ASSAM); 3000-5000 ft., without date, J.D.H(ooker) 33, 303 (K, photo!). Tripura:

Agartala, 10.iv.1956, D.B. Deb 253; Kailasham, 16.viii.1960, D.B. Deb 2645 (CAL). W. Bengal: Darjeeling, Kodabari, 3000 ft., Aug. 1881, J.S. Gamble 9749 (ASSAM, DD).

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November 15, 1998

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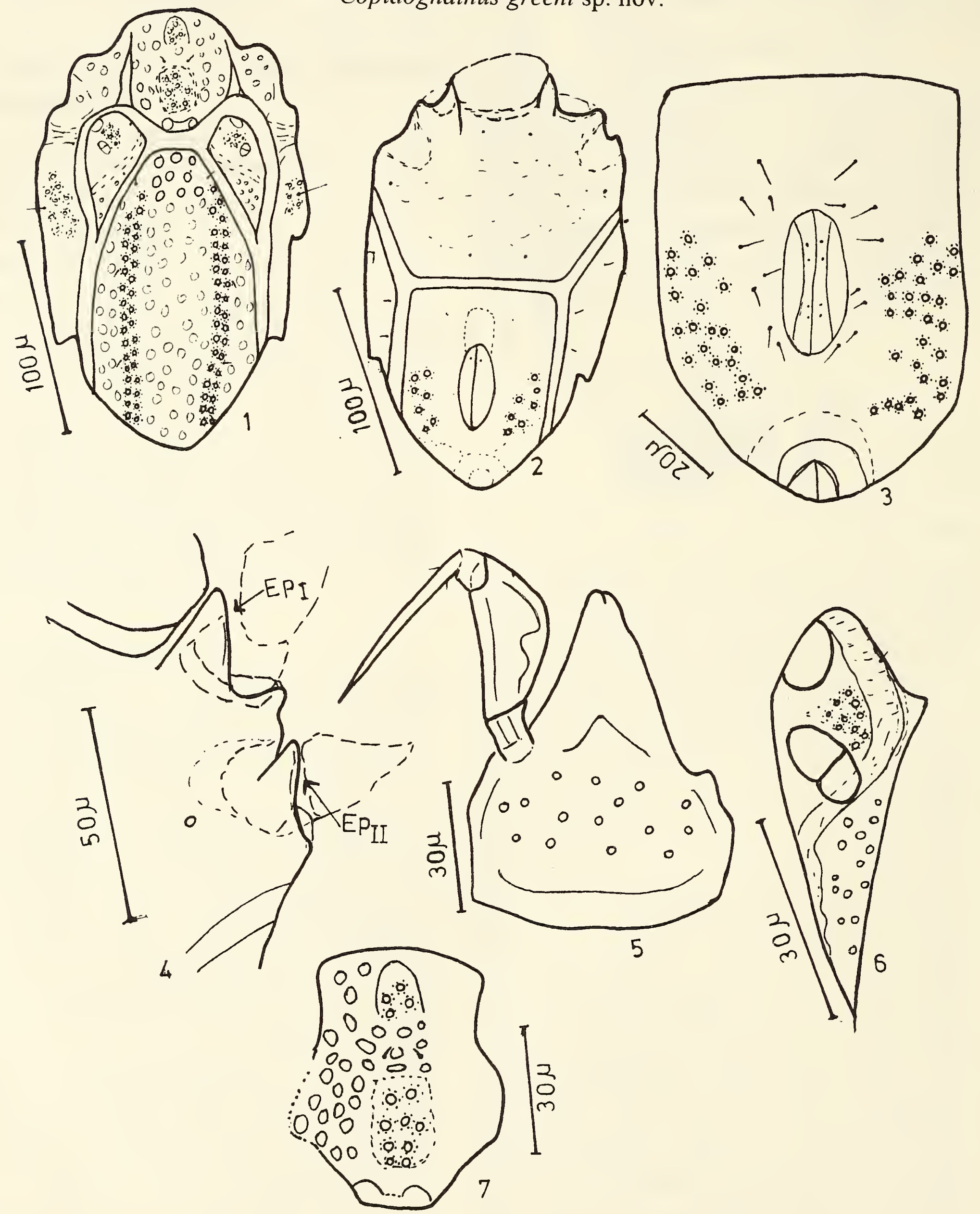
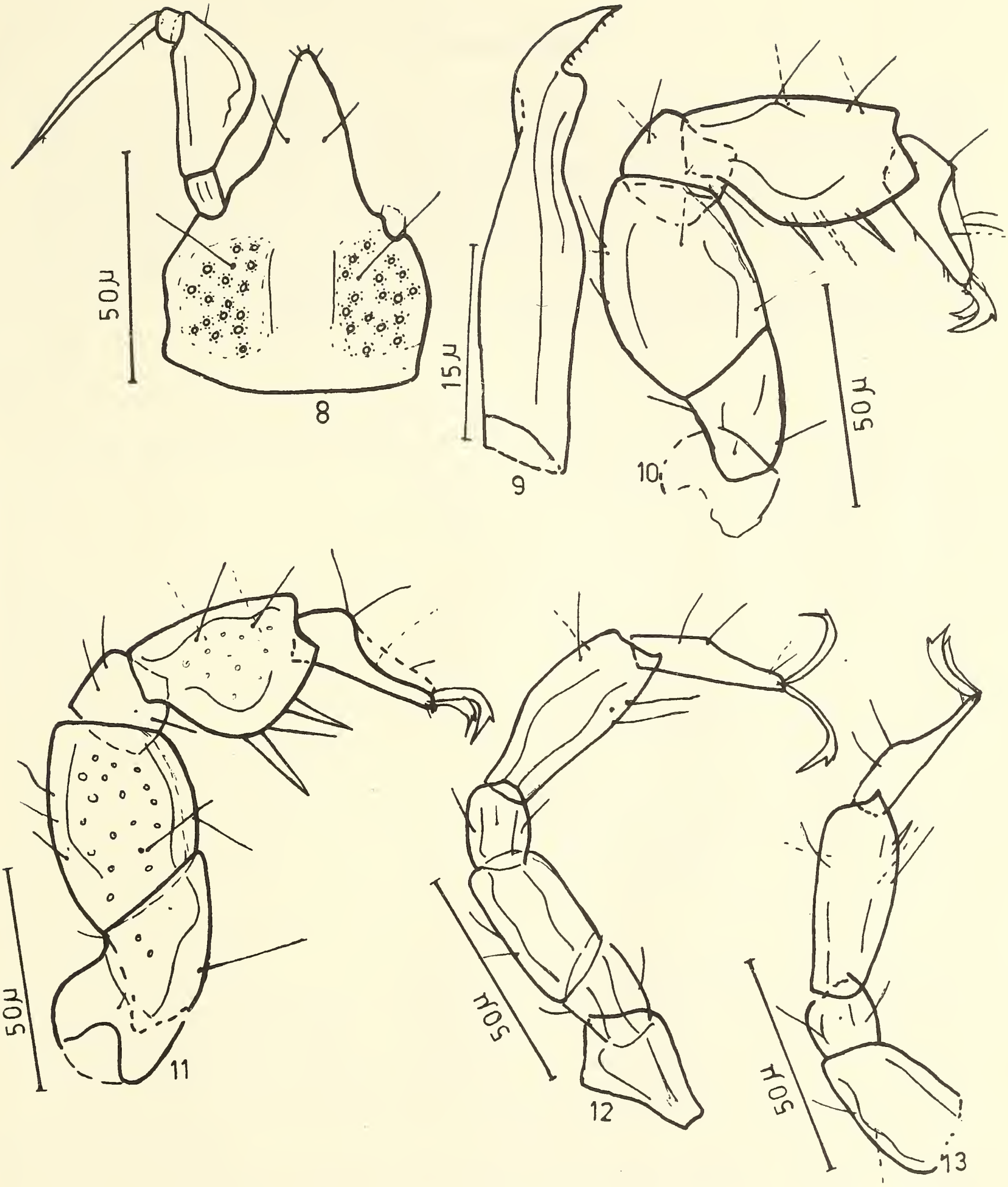
ERRATA

Vol. 96 No. 3, December 1999, pp. 448-449 refer to the following thirteen text-figures for *Copidognathus greeni* sp. nov.



Figs. 1-7: *Copidognathus greeni* sp. nov. 1. Idiosoma dorsal (E), 2. Idiosoma ventral (E), 3. GA of G, 4. Magnified view of Epimeral process, 5. Gnathosoma, dorsal view, 6. OC, 7. Magnified view of AD.



Figs. 8-13: *Copidognathus greeni* sp. nov. 8. Gnathosoma, ventral view, 9. Chelicera, 10. Leg. I, 11. Leg II, 12. Leg. IV, 13. Leg. III (Telofemur-tarsus).

CORRIGENDUM

Reference is drawn to a recent note by Raju Thomas *et al.* (Distribution of *Pangio goaensis* (Tilak) Cypriniformes : Cobitidae in Manimala river, Southern Kerala, *J. Bombay nat. Hist. Soc., 96(3)*: 479-480), in which the authors have referred to a paper by Rema Devi *et al.* which they presumed had appeared in *J. South Asian nat. Hist. 1996, 3(1)*: 19-22, on their having seen the paper at the proof stage with the author. In a recent communication, Dr. Rema Devi has informed the editors that the said paper had not been published as reported since it was withdrawn at an advanced stage of its publication, four years after its submission. This paper shall appear in a future issue of the *JBNHS*.

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CONTENTS

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AUGUST 2000 Vol. 97 (2)

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CONTENTS

NEW DESCRIPTIONS

REVIEWS

MISCELLANEOUS NOTES

Cover photograph: *Honeybees on Elephant Bamboo Flower*
K.C. Koshy

Editorial

Forty million years ago, honeybees appeared on earth in the Eocene period. They acquired their social habit only 10 million years later. Honey bees are believed to have originated in Africa and later spread to Europe and to Asia. They were brought to the Americas and are now distributed all over the world. The true honeybees belong to the genus *Apis* Linnaeus of the family Apidae. Seven species of honeybees are known from the world. They are *Apis dorsata* Fabricius, *Apis cerana* Fabricius *Apis florea* Fabricius, *Apis mellifera* Linnaeus, *Apis andreniformes* Smith, *Apis nigrocincta* Smith and *Apis koschenvnikovi* Enderlein. Except for the last two, all are found in the Indian subcontinent. The bees arose from ancestors of Spheciformes, abandoned their predatory habit of feeding on insect larvae or spiders and shifted to phytophagy. By mixing pollen with nectar and honey or with floral oils, they prepared food for their larvae.

In the cover photograph, two species of honeybees namely *Apis dorsata dorsata* Fabricius (larger form) and *Apis cerana indica* Fabricius (smaller form) are seen foraging on the flowers of the bamboo *Ochlandra travancorica* (Beddome), commonly known as *irul, iral,* or *eeta* in the local languages, as elephant bamboo and reed bamboo in English. It is endemic to the southern Western Ghats and grows at elevations of 1,000-2,500 m, as undergrowth in evergreen and semi-evergreen forests, commonly along the banks of rivers and streams. It is economically important, since its culms are used for paper pulp, mat making and basket weaving. The mats are used for making ply bamboo. It is also used in rural housing. The leaves are eaten by elephants.

Apis dorsata is the largest honeybee in the world and is unfit for domestication. It builds its comb on inaccessible branches of trees. A comb may measure 1 to 5 metres in length. Each comb may contain 20-38 litres of honey, depending on its size. *Apis cerana,* the smaller bee, is a species suitable for apiculture. The subspecies *Apis cerana indica* Fabricius, known as the Indian honeybee, is seen in peninsular India. These bees are most active in foraging on flowers, usually at a temperature range of 25-28 °C and humidity of 70-80% R.H. The yield of honey is proportional to the availability of bee pasturage in the locality. According to recent information, the poison gland of *Apis cerana* contains a compound known as eicosenol in quantities larger than in other species of bees. It is probable that the bee uses this pheromone to mark the flowers rich in nectar, so that other bees of the colony can locate the flowers quickly; or this may be an alarm pheromone to alert the hive mates when an intruder comes to the hive. Strangely enough, while foraging on the flowers of *Ochlandra travancorica,* both species damage the anthers.

T.C. NARENDRAN

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August 2000 Vol. 97 No. 2

PHEASANT ABUNDANCE IN SELECTIVELY LOGGED AND UNLOGGED FORESTS OF WESTERN ARUNACHAL PRADESH, NORTHEAST INDIA[1]

APARAJITA DATTA[2]

(*With one text-figure*)

Key words: Abundance, Arunachal Pradesh, kaleej pheasant, *Lophura leucomelana lathami*, logging, northeast India, peacock-pheasant, *Polyplectron bicalcaratum*, red jungle fowl, *Gallus gallus*

Relative abundance of three pheasant species was compared along trails, across recently logged forest, 20-25 years old logged forest, unlogged primary forest, a relatively disturbed primary forest and a mixed-species plantation in Pakhui Wildlife Sanctuary, and Doimara and Papum Reserve Forests, Arunachal Pradesh, northeast India. The three pheasant species recorded were the red jungle fowl (*Gallus gallus*), black-breasted kaleej pheasant (*Lophura leucomelana lathami*) and the grey peacock-pheasant (*Polyplectron bicalcaratum*). Overall pheasant abundance was highest in unlogged forest and low in all other strata. No pheasants were sighted in the plantation. All three species were most abundant in unlogged forest. The probable causes of the relatively low abundance of pheasants in logged and disturbed forests are discussed especially in relation to subsidiary impacts of logging such as increased human disturbance and hunting due to easier access through logging roads.

INTRODUCTION

During a six month study on the responses of arboreal mammals to selective logging in western Arunachal Pradesh, India, the relative abundance of three pheasant species was also recorded systematically along trails. The pheasant species were the red jungle fowl (*Gallus gallus*), black-breasted kaleej pheasant (*Lophura leucomelana lathami*) and grey peacock-pheasant (*Polyplectron bicalcaratum*). These species were compared across 5 categories of traits, i.e., plantation, semi-disturbed forests, old logged forests, recently logged and unlogged primary forests.

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An earlier survey solely for pheasants in the same area reported the occurrence of the grey peacock-pheasant and the red jungle fowl (Kaul and Ahmed 1992). The kaleej was not sighted during that survey. The grey peacock-pheasant was encountered in densely forested areas with undulating terrain in the earlier survey. Its presence was mostly ascertained from calls. Kaul (1993) suggested that estimates of population densities of peacock-pheasant and red jungle fowl can be made from call counts in the Eastern Himalaya.

STUDY SITES

The study sites were located in Pakhui Wildlife Sanctuary (WLS) and Doimara and Papum Reserve Forests (RF) in east and west Kameng district, western Arunachal Pradesh

(Fig. 1). Pakhui WLS covers an area of 862 sq. km and is bounded on the north and west by the Bhareli river, on the east by the Pakke river, and the south by the Nameri WLS and reserve forests of Assam. Doimara RF lies to the west of Pakhui WLS in west Kameng district, while Papum RF lies to the east, in east Kameng district. Both the RFs fall in the Khellong Forest Division and together cover about 300 sq. km. The area lies in the foothills of the Himalaya and the terrain is undulating and hilly. The altitude ranges from 200 to more than 1,500 m above msl. The vegetation is tropical, semi-evergreen, with moist areas near streams having a profuse growth of bamboo, cane brakes and palms. The forest has a typical layered structure with the major emergent species being *Tetrameles nudiflora*, *Altingia excelsa* and *Ailanthus grandiflora*. There is a distinct middle storey; the understorey is largely made up of shrubs such as *Clerodendron*. The forests are rich in woody liana and climber species as well as epiphytic orchids and ferns.

The area has a great diversity of mammalian fauna. The ungulates found here include gaur (*Bos gaurus*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjac*) and wild pig (*Sus scrofa*). Elephants were sighted several times in the sanctuary, and once in the plantation. Carnivore fauna includes the tiger (*Panthera tigris*) leopard (*P. pardus*), clouded leopard (*Neofelis nebulosa*), smaller cats and several civet species. Three primate species namely, rhesus macaque (*Macaca mulatta*), Assamese macaque (*M. assamensis*) and the capped langur (*Semnopithecus pileata*) and four squirrel species, the Malayan giant squirrel (*Ratufa bicolor*), Pallas red-bellied squirrel (*Callosciurus erythraeus*), hairy-bellied squirrel (*Callosciurus pygerythrus*) and Himalayan striped squirrel (*Tamiops macclellandi*) are the most commonly encountered mammals. A total of 256 bird species have been recorded from the area (Singh 1991, 1994, Datta *et al.* 1998).

Description of Census Trails

Plantation - Trail 1, Seijusa-Monai (Papum RF): Trail walks totalled 34.5 km. A logging road was used for the census. The altitude ranged from 400 to 500 m above msl. The plantation was mixed; the major species were *Terminalia myriocarpa*, *Duabanga grandiflora*, *Phoebe goalparensis*, *Bombax ceiba*, *Gmelina arborea* and the exotic *Tectona grandis*. This plantation borders the reserve forests of Assam. There are settlements surrounding this area with patches of cultivation and degraded forest. The total area covered by the plantation is *c.* 3-4 sq. km.

Semi-disturbed forests - Trails 2 & 3, Khari (Pakhui WLS): A total of 30.94 km was walked in this habitat. The two trails identified for monitoring were replicated 7 times each. These were elephant trails/paths at 450 to 550 m above msl. The trails were adjacent to steep gullies and *nalas*; canes and palms were abundant, bamboo clumps occurred along the slopes. Cane extraction on a commercial basis occurred till 1991. Cane-cutters occasionally enter the forests from the adjacent reserve forests of Assam. The area is adjacent to Nameri WLS, Assam, and lies in the southern part of the sanctuary. It has not undergone selective felling in the past.

Old logged forest - Trail 4, Seijusa-Khari (Pakhui WLS): Census walks totalled 27 km. A trail of 2.7 km was replicated 10 times at altitudes ranging from 550 to 800 m above msl. A patrolling trail cut by the Forest Department staff in 1994 was used. An area of *c.* 4 sq. km had been selectively felled when the Pakhui Sanctuary was a reserve forest, prior to 1978. This area also lies in the extreme southeastern part of the sanctuary near the Arunachal Pradesh-Assam border. Several colonizing species such as *Bauhinia purpurea* and *Mallotus* sp. common in secondary forests, occurred here.

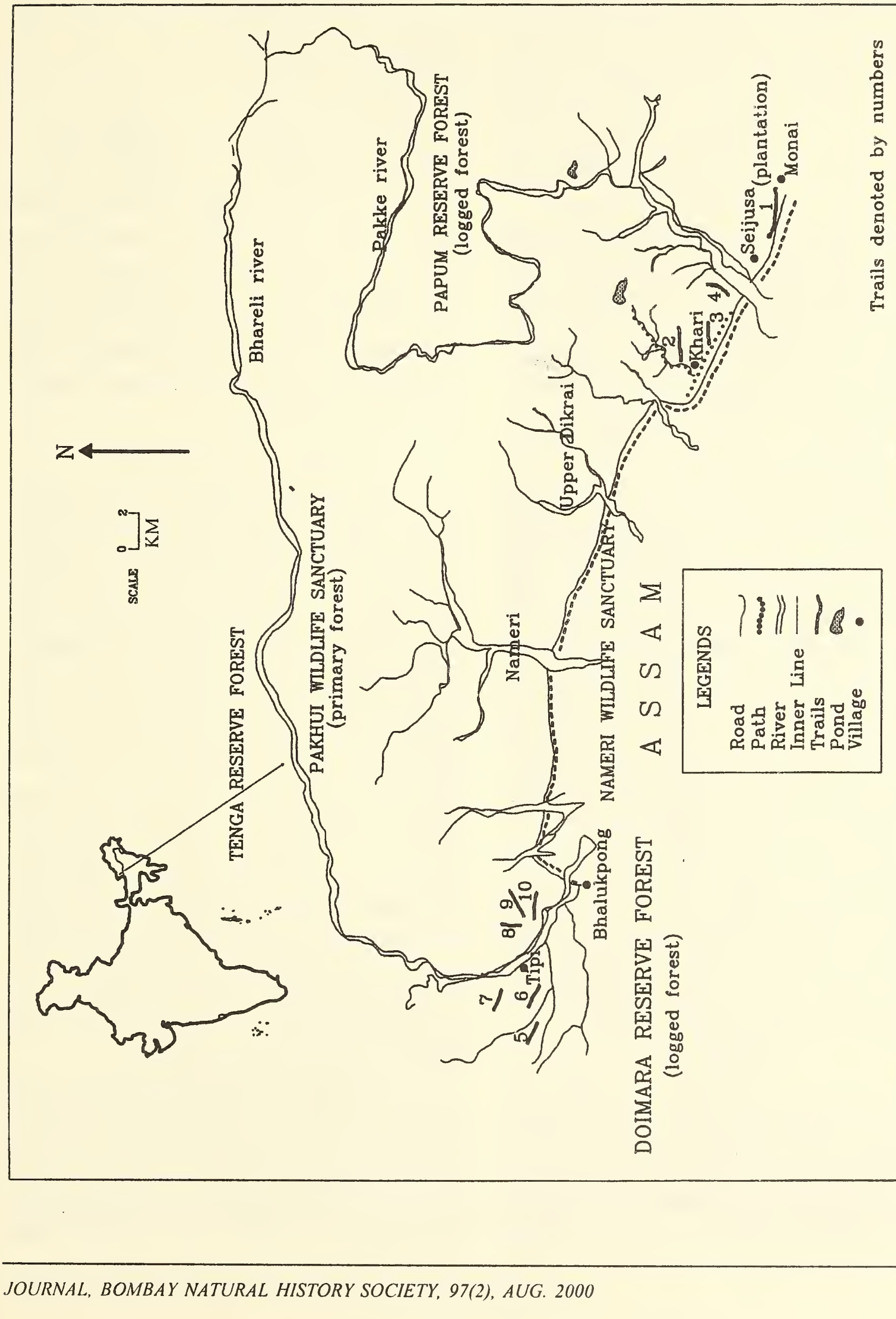

Fig. 1: Map of the Study area

Recently logged forest - Trails 5, 6 & 7, Tipi, west of Bhareli river (Doimara RF): A total of 53.28 km was covered in this habitat. Three trails varying in length from 1.7 to 3 km were replicated 8 times each. The altitude ranged from 500 to 850 m above msl. The area is close to Tipi with a human population of about 900. Logging operations were active along two of the trails and had concluded in the third trail. A few small labour camps occurred in the logged forest sites. Elephants and small trucks were used to transport the logs to the two sawmills and one plywood mill nearby. Due to the presence of both reserve forests and a sanctuary on all sides, the forests in this region are contiguous. The Bhareli river and Tezpur-Bomdila highway act as the boundary between Pakhui WLS and Doimara RF.

Unlogged primary forest - Trails 8, 9 & 10, Tipi, east of Bhareli river (Pakhui WLS): Census walks totalled 41.4 km. The three trails were located near the southwest boundary of the sanctuary across the River Bhareli from Tipi. Two existing patrolling trails were used and one additional trail had to be cut for the census walks. A vast portion of the central and northern parts of the sanctuary is quite inaccessible due to the dense vegetation, hilly terrain and the lack of trails. The sole village, Mabusa, to the south of the sanctuary, has been relocated outside the boundary of the sanctuary. One or two settlements are present near the northern boundary. The Bhareli river acts as a barrier to human disturbance, though occasionally local tribals may cross over. Therefore, most of Pakhui WLS, except a small strip to the south, has excellent undisturbed primary forest.

Methods

Five habitats were selected, based on their logging history. The trails in the different habitats were so selected as to be similar in general vegetation type (though abundances of various species and composition differed somewhat), rainfall and altitude.

Ten trails, adding to a total of 187.12 km, were walked in five habitats, each being replicated 6-10 times during the study period from December 1995 to April 1996. All trails were walked in the morning, and the calls and sightings of pheasants were recorded. Relative pheasant abundance was compared using a simple measure of encounter rate; numbers seen/heard per km. Both calls and direct sightings were used in the calculation of encounter rates. Since sightings were few, statistical comparisons were not made. Encounter rates were simply calculated by dividing the total number of calls and sightings in each habitat by the total distance walked in each habitat.

Results and Discussion

Three pheasant species were recorded, namely, the red jungle fowl (*Gallus gallus*), black-breasted kaleej pheasant (*Lophura leucomelana lathami*) and the grey peacock-pheasant (*Polyplectron bicalcaratum*). All three species were recorded in unlogged and logged forest. Only the peacock-pheasant was heard in semi-disturbed forest along the trails, though the red jungle fowl was heard/seen there otherwise. The red jungle fowl and peacock-pheasant were also recorded in the old logged forest. No pheasant species were recorded in the plantation. Partridges were also sighted twice in the unlogged forest but could not be identified. The white-cheeked partridge (*Arborophila atrogularis*) has been reported earlier (Singh 1994).

Overall abundance of pheasants was highest in unlogged forest (0.70/km), n = 29 (calls and sightings). All other habitats had much lower abundance (Table 1).

Though the peacock-pheasant was never sighted, vocalization confirmed its presence in all the habitats except the plantation. It was the most abundant in unlogged forest (0.34/km, n = 14 calls), followed by semi-disturbed forest (0.16/km, n = 5 calls). They were heard only

TABLE 1
ENCOUNTER RATES OF PHEASANTS IN THE FIVE STRATA

	Unlogged Forest	Semi-disturbed Forest	Old logged Forest	Logged Forest	Plantation
Overall	0.70/km	0.16/km	0.11/km	0.11/km	-
Red jungle fowl	0.10/km	-	0.07/km	0.09/km	-
Kaleej pheasant	0.26/km	-	-	0.02/km	-
Peacock-pheasant	0.34/km	0.16/km	0.04/km	*	-

* Heard call once, but not during trail walk

once each in the old logged forest and in logged forest. This species was very vocal, calling frequently from 0600 hrs onwards. Within India, the peacock-pheasant occurs only in the northeast, and is generally found in dense evergreen and semi-evergreen forest. Like the kaleej, it prefers to be near water, especially in the breeding season (Johnsgard 1986). The species reportedly thrives under conditions of secondary forest succession (Johnsgard 1986), but is highly vulnerable to snaring (Baker 1930). Feathers of a dead bird were found in Khari; trapping and snaring occurs occasionally. Remains of peacock-pheasants have been seen elsewhere in Arunachal Pradesh (Athreya and Karthikeyan, unpubl. data; Kaul and Ahmed 1992; *pers. obs.* 1996; Rashid Raza, *pers. comm.* 1995; Vidya Athreya, *pers. comm.* 1995). A freshly killed specimen of peacock-pheasant and several traps for pheasants were seen in West Khasi and Garo hills in Meghalaya (A. Christy Williams, *pers. comm.* 1995).

Kaleej pheasant was sighted only in unlogged forest and heard once each in old logged forest and in logged forest. Kaleej was sighted on ten occasions and a call was heard once in unlogged primary forest (0.26/km). The kaleej has an overall wide distribution and survives well in a variety of disturbed and undisturbed habitats and reportedly withstands hunting pressure fairly well (Bump and Bohl 1961) . This is not borne out by the present observations, since kaleej were sighted only in unlogged forest. It is, however, not very vocal, and overall abundance may thus have been underestimated. All literature pertaining to this species cites the importance of proximity to water (Baker 1930, Ali and Ripley 1983, Johnsgard 1986). Ample rock cover and proximity to water are reported to be major requirements for nesting (Johnsgard 1986).

Red jungle fowl was recorded in three habitats during the trail walks. This species was marginally more abundant in unlogged forest (0.10/km) than logged forest (0.09/km) and old logged forest (0.07/km). Red jungle fowl occurs in a wide range of habitats, and is reportedly more common in secondary forests associated with abandoned clearings, or edges of bamboo forest (Johnsgard 1986). During this survey, it was found to be marginally more abundant in unlogged forest than logged and old logged forest. This could be related to more intense hunting for pheasants in the logged areas or to their being shy of human presence.

The dissimilar calling patterns of these pheasant species could have biased the observed encounter rates. In addition, the main calling period for all these species is from March to May (Johnsgard 1986). Kaul & Ahmed (1992) sighted/heard more red jungle fowl than peacock-pheasant and attributed this to their more noisy habits, and propensity for feeding at the edges of roads. During this study, I used only the existing small trails in the forest which were different from the ones used in the earlier survey (Kaul and Ahmed 1992), hence red jungle fowl were probably encountered less during this study. The peacock-pheasant was the most commonly encountered pheasant because of its frequent

vocalization early in the morning. These birds remain in dense undergrowth and are great skulkers (Ali and Ripley 1983), therefore direct sightings are rare. The kaleej pheasant does not have a regular calling pattern and usually calls only when flushed. Therefore, its abundance may have been underestimated. Unlike the red jungle fowl, kaleej are said to be usually silent during the day (Ali and Ripley 1983).

It is surprising that there were so few encounters with pheasants in the logged forest, old logged forest and semidisturbed forest despite the fact that all three sites had a profusion of bamboo clumps in some areas, whereas bamboo was not recorded in the vegetation plots in unlogged forest. According to Ali and Ripley (1983), all the 3 pheasant species discussed here are partial to bamboo seeds. But mass flowering of bamboo is sporadic, and therefore the presence of bamboo may not be important to pheasant abundance. These birds are largely omnivores, feeding on grain, seeds, tubers, insects, small snakes and lizards. Insect abundance was not estimated for a comparison of food availability between these areas, but reduced insect abundance in logged forest has been reported (Johns 1986).

Canopy cover and degree of disturbance may be more important in affecting pheasant abundance. Canopy cover, tree density and basal area were reduced in logged forest and plantation (Datta and Goyal 1997). Johns (1989) found that terrestrial birds are more severely affected by logging because of the effects of microclimatic changes on the leaf litter fauna which were entirely absent from recently logged forest. Physiological considerations (heat and water balance) may be more important in determining the movement patterns of understorey birds than local food abundance (Karr and Freemark 1983). Habitat changes, such as destruction of understorey, affect all pheasants (Gaston 1982). The reduced canopy cover and tree density in logged forest and plantation definitely changes the microclimate in the understorey due to increased insolation. Semi-disturbed forest and old logged forest, though similar in canopy cover and tree density to unlogged forest, were subject to human disturbance in the form of occasional cane-cutters from Assam. There are also stray reports and evidence of trapping of pheasants by local tribals in this area.

Katti *et al.* (1992) reported that hunting by the tribals is more severe in the foothill forests near villages. This, coupled with increase in non-tribal populations and road construction in and around reserve forests (logged areas) results in more disturbance. Pheasants and other large birds such as hornbills are worst affected by hunting (Katti *et al.* 1992). Johns (1986, 1989) states that partridges (Phasianidae) do not survive logging successfully, though the effects on pheasants are not mentioned. Wilson and Johns (1982) found that the great argus pheasant (*Argusianus argus*) was most abundant in unlogged primary forest, in reduced numbers in 3-5 years old logged forest, and totally absent from disturbed, recently logged forests and plantation. Therefore, reduced pheasant abundance in logged and disturbed forests and a total absence in the plantation seems to be caused by a combination of modified habitat, human presence and the consequent trapping and snaring of these terrestrial birds. There is also a possibility that the observed pattern is due to these birds being shy of human presence in logged and disturbed forests, the birds' greater alertness because of occasional trapping by the local labour and tribals. Therefore, even though logging may not directly affect them, the construction of roads in logged areas leads to increased accessibility to local people for hunting. The movement of people and presence of labour camps during and after logging operations results in disturbance. The unlogged primary forest, on the other hand, is little disturbed by hunting or human presence, consequently birds are not shy and can be sighted

or heard at closer quarters. The greater numbers of pheasants encountered in unlogged primary forest, despite the dense vegetation and lower visibility, is indicative of the importance of such habitats to pheasants, rather than modified habitats.

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FLORAL DIVERSITY OF GORIGANGA VALLEY IN THE CENTRAL HIMALAYAN HIGHLANDS[1]

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(*With one text-figure*)

Key words: Himalaya, Goriganga valley, flora, diversity, endangered species

An extensive and intensive survey of the floral diversity of the Goriganga valley in the Central Himalayan ranges was carried out. About 1,081 species of flowering plants belonging to 496 genera and 116 families were recorded. A number of plant taxa were found endemic to the area. The valley was extremely rich in orchid species. Studies showed that a number of plant species, represented by small population sizes recorded earlier, were found no more in the valley. It was concluded that increasing biotic pressures would severely jeopardize the biological wealth of this valley if conservation management plans are not implemented.

Introduction

Himalaya, the youngest mountain system of the world, constitutes an important bridge between floras of northwestern and western Asia, Europe and southern peninsular India on the one hand and the eastern Malesian, northeast Asian, Sino-Japanese and northern Tibetan areas on the other. The Himalayan uplift that took place in a series of orogenies brought about a corresponding change, not only in the climatic profile along the altitudinal gradient, but also in the edaphic factors of these uplands (Kumar and Subramaniam 1985). These changes influenced and paved the way for the immigration of plant species from far off regions, east and west, their establishment in the ecosystems, and speciation and extinction during various geological ages. The trend of colonization and formation of stabilized communities followed by speciation in the Himalaya continued even in the Modern Age (Raina *et al.* 1978, Kumar 1983). Phyto-geographically and ecologically, it is, therefore, one of the most complex biomes in the Indian subcontinent with marked east-west and south-north transitions. It serves as a biological platform for overlapping Indo-Chinese and Middle Asiatic amphitheatres (Puri *et al.* 1983).

The geophysical features of the Himalayan region are marked by geological instability, leading to an active process of erosion, massive moraine deposits, precariously perched glacial lakes, avalanches, mudflows, high snowfall and monsoon precipitation. Besides, the biological components, both terrestrial and aquatic, constitute an intricate ecological system of this region. The seral plant communities on the newly stabilized debris fans, in the lower reaches, and moraines in the higher valleys, hold the debris masses, which would otherwise end up in stream and river channels, thereby disrupting the ecological balance of the riverine and riparian ecosystems (Kumar *et al.* 1993). The keystone plant species in various ecosystems in the region are essential for maintenance of their structure and function, including prevention of soil loss and regulation of hydrological cycle (Ehrlich and Mooney 1983). The vegetation cover provides the human population with vital life support and socio-economic security. Timber, fish and medicinal herbs are primary resources for the human population living in these Himalayan highlands on a marginal economy.

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Though studies on the flora of Goriganga valley have been conducted by earlier workers like Sahni and Raizada (1955), Rao (1959), Nair (1966), Arora and Prasad (1980), Pant and Naithani (1981), Rawat (1982), Kalakoti and Pangtey (1982), Kalakoti *et al.* (1983), Malhotra and Balodi (1984 a,b,c,d,e), Malhotra and Balodi (1985), Malhotra *et al.* (1985), Seidenfaden and Arora (1982) and Balodi (1988), they have concentrated only on specific localities or taxa. A comprehensive account of the floristic aspects was not available. This study attempts to present an integrated account of the floristic composition of the valley and changes in recent years.

Study Area

Fig. 1 depicts the study area and location of the Goriganga valley. The valley forms the easternmost part of the Kumaon Himalaya in the vicinity of the Indo-Nepal border. The valley lies between 79° 58' 50" to 80° 29' 36" E long. and 29° 45' 3" to 30° 18' N lat. The Goriganga valley is bounded in the north by the Tibetan plateau and in the east by the Panchachuli ridge, which separates it from the adjoining Dhauliganga valley. The Nanda Devi massif lies northwest, while the Nandakot-Bankatiya ridge marks the western boundary. Kalsin Danda (ridge) marks the southern boundary. The Goriganga river originates from Milam glacier (3,600 m) and traverses a distance of 100 km before merging with River Kali at Jauljibi (600 m). The Goriganga valley, with a catchment area of 2,230 sq. km covers sub-tropical to alpine climatic zones, which coincide with the Lesser, Greater and Tethyan Himalayan geological domains.

The Lesser Himalayan area, south of Munsyari also known as Goriphat, is spread from Jauljibi to Madkot and has the largest human population, with a density of 15 individuals per sq. km. This area is intensively terraced for agriculture and has a rich cultural and ethnic diversity. It enjoys a hospitable climate, numerous freshwater streams, and also harbours a rich and diverse vegetation cover and wildlife.

The Greater Himalayan domain, beginning from Munsyari upstream to Rilkot, is characterised by a harsher climate, narrow valleys, deep gorges and steep slopes prone to massive landslides and avalanches. This area is thickly forested with moru oak (*Quercus floribunda*), kharsu oak (*Q. semecarpifolia*) and mixed broad-leaf coniferous forests. These forest types harbour a rich diversity of economically important species, like timber-yielding trees, medicinal herbs and plants of horticultural value. In the past, this inhospitable terrain had no permanent human settlements, and even today it remains more or less uninhabited.

The region lying beyond the Greater Himalaya, the Tethys, is characterised by gentle relief, wide U-shaped valleys with huge moraine deposits along the river and stream channels having low gradient. The winters are much prolonged with minimum temperature falling to -20 °C, and a high frequency of avalanches. However, the mineral rich moraine deposits, numerous streams and brooks, and gentle gradient of the area offered habitable terrain to earlier human settlers from across the border — the Tibetan highland. They brought with them different social and cultural norms and a different ethnic stock, and occupied the territory extending all along the Tethyan belt in the Himalayan region.

Material and Methods

The plant collections were made during different treks and expeditions to the Milam glacier, Mandakani valley, Sera gad, Rachi gad, Goshi gad, Chhiplakot areas, and the Goriganga valley proper, over a period of two years, in different seasons. The plant specimens were identified with the help of floras and checklists from previous explorations of this area. Some specimens were compared with the type specimen

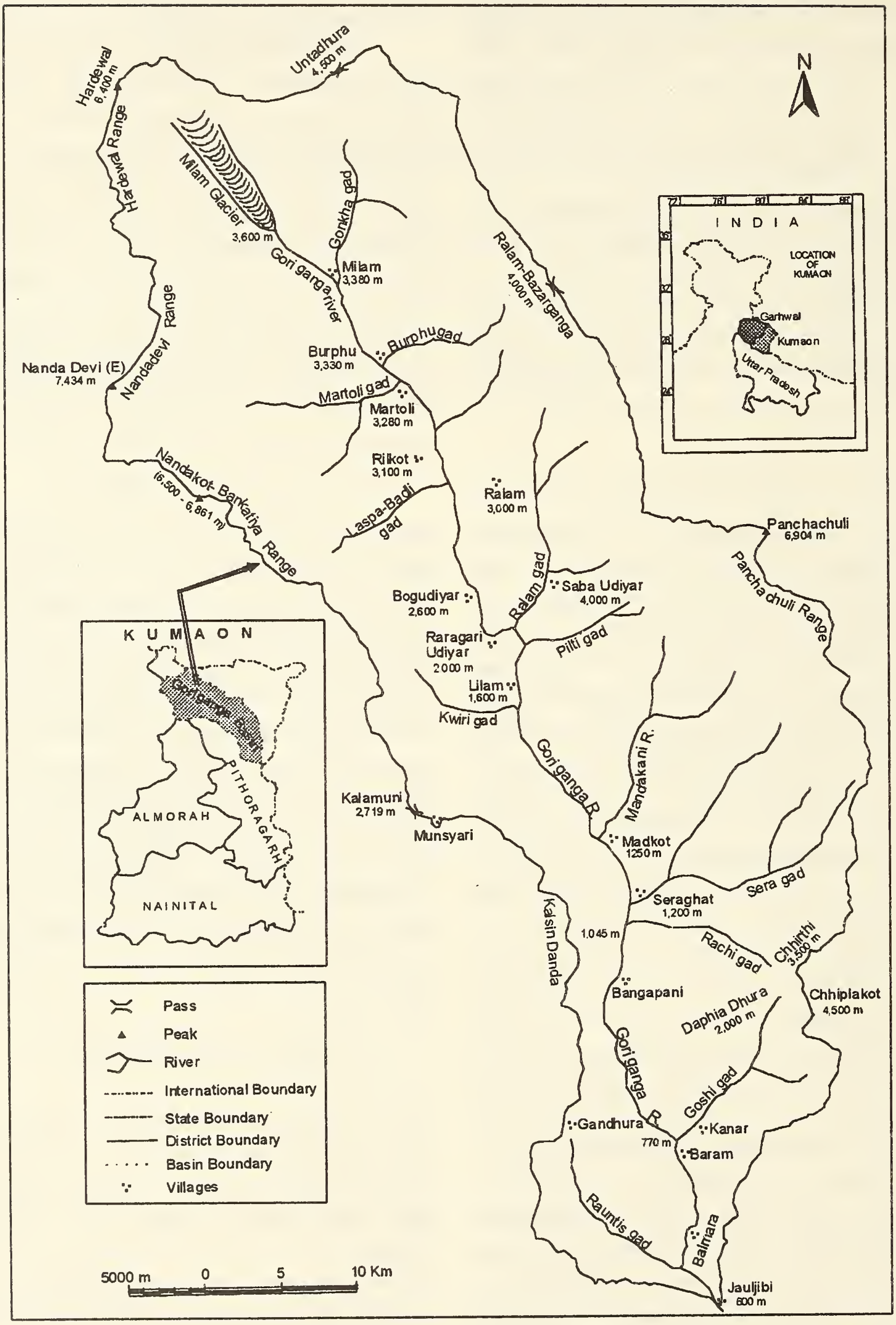

Fig. 1: Location map of Goriganga basin showing major tributaries and places

at the herbarium of the Botanical Survey of India, Dehra Dun. An inventory was prepared after plant collection, recording and authentication of species.

Results and Discussion

Taxonomic Diversity: A total of 1,081 species of flowering plants were recorded (of the more than 3,000 in Himalaya and 20,000 in India). These belong to 496 genera (out of the 2,917 in India) and 116 families (out of the 327 in India). Out of 116 families represented in the valley, 100 are dicots and the rest are monocots, the ratio of monocot to dicot species is 1:4.41 (192 monocots, 850 dicots). The predominant families and the number of genera and species represented by them in the valley are given in Table 1. Among the angiosperm genera, each of the following were represented by 10 or more species: *Potentilla* (19), *Saxifraga* (19), *Astragalus* (13), *Gentiana* (13), *Pedicularis* (13), *Saussurea* (13), *Sedum* (13), *Corydalis* (11), *Stellaria* (11) and *Rubus* (10).

Table 1

PREDOMINANT FAMILIES, THEIR GENERA AND SPECIES IN GORIGANGA VALLEY

Family	Genera	Species
Asteraceae	39	83
Orchidaceae	36	69
Rosaceae	19	69
Poaceae	35	58
Fabaceae	24	55
Ranunculaceae	13	50

New Records of Plant Species: During the past 20 years, many new species have been recorded from the Goriganga valley which are either new records for West Himalaya or Kumaon Himalaya. Malhotra and Balodi (1985) reported *Salix lindleyana* var. *microphylla* and *Epilobium trilectorum*, which are new records for India. Balodi and Malhotra (1984) for the first time recorded *Ribes griffithii* from West Himalaya. *Anemone trullifolia*, *Aconitum atrox*, *Delphinium viscosum* and *Saussurea polystephoides* are the new records for west Himalaya reported by Rawat (1982). Similarly, there have been new records for northwest Himalaya from Goriganga valley: *Crassocephalum crepedioides* by Kalakoti and Pangtey (1982), *Oxalis tetraphylla* by Kalakoti *et al.* (1983), and *Elatostemma sessilis* by Malhotra and Balodi (1985). We also recorded these taxa in Goriganga valley.

The most striking feature of the flora of this area is the number of new records for Kumaon Himalaya. Rawat (1982) reported a number of new species from Goriganga valley which are as follows: *Aconitum atrox*, *Anemone elongata*, *Beibersteinia odora*, *Briza media*, *Chrysoplenium carnuosum*, *Hedinia tibetica*, *Potentilla fruticosa* var. *rigida*, *P. nivea* var. *himalaica*, *Polygonatum graminifolium*, *Sibbaldia cuneata* var. *micrantha* and *Stellaria depauperata*. Arora (1980) reported a number of new species of orchids, namely *Dendrobium porphyrochilum*, *Eria muscicola*, *E. reticosa*, *Gastrochilus acutifolius*, *Kingidium deliciosum*, *Malaxis rheedi*, *Oberonia caulescens*, *O. griffithiana*, *Ponerorchis nana* and *Thelasis longifolium*. Our field studies confirm the presence of all these orchid species in various habitats of the valley. This concentration of orchid species is an unusual feature of western Himalaya, where orchids are not found with such frequency and abundance as in the eastern Himalaya.

Sahni and Raizada (1955), during their expedition to Panchachuli, made new records for the Kumaon Himalaya, namely *Anemone tetrasepala*, *Ranunculus laetus* and *Salix oxycarpa*. Generally, intensive exploration of inhospitable areas leads to the discovery of new plant species. Some of the potential areas in Goriganga valley, which are likely to harbour new plant species are the Ralam valley, Chhiplakot range, Gwars (meadows) in the

Panchachuli and Bankatiya ranges and forests around Bogudiyar.

Endemism: There are nearly 30% dicots endemic to the Himalaya (Puri *et al.* 1983). Some of the endemic Himalayan plant taxa which are also present in the Goriganga valley are *Meconopsis aculeata*, *Ougeinia oojeinensis*, *Cortia lindleii*, *Nardostachys jatamansi*, *Aechmanthera gossypiana*, *Hemiphragma heterophyllum*, *Picrorhiza kurrooa*, *Falconeria himalaica*, *Phlogacanthus thyrsiformis*, *Dodecadenia grandiflora*, *Eria occidentalis* and *Flickingeria hesperis*. The most interesting of these is *Falconeria himalaica*, a rare plant, which was recorded near Munsyari and has a very limited distribution, i.e. only in the Garhwal and Kumaon Himalaya.

Monotypic Genera: Goriganga valley abounds in monotypic genera, which are as follows: *Asperugo procumbens* (Boraginaceae), *Boeninghausinia albiflora* (Rutaceae), *Circaester agrestis* (Circaesteraceae), *Falconeria himalaica* and *Hemiphragma heterophyllum* (Scrophulariaceae), *Cortia lindleii* (Apiaceae), *Parochetus communis*, *Ougeinia oojeinense* (Fagaceae) and *Oxyria digyna* (Chenopodiaceae).

The presence of endemic species and monotypic genera indicates active processes of speciation in this region. Moreover, the majority of these species are polyploids (Kumar and Subramaniam 1985), clearly pointing out their neo-endemic nature (Lewis 1972).

Epiphytic Flora: Angiospermic epiphytes occurring in the valley mostly belong to the families Orchidaceae and Asclepiadaceae. There are 42 epiphytic orchid species, which are described later in this paper. Other epiphytic flora of the valley includes *Hoya lanceolata* and *H. longifolia*. There is an abundance of epiphytic ferns too. *Lycopodium annotinum*, *Polypodium linearis*, *P. flocculosum* are mainly found near Bogudiyar. The richness of the epiphytic flora in the valley seems to be a result of the geophysical environment, marked by the presence of numerous streams, river channels and warm temperate conditions at lower elevations, giving rise to high humidity in which epiphytes thrive.

Parasitic Flora: Parasitic flora in the valley belongs to the families Loranthaceae, Orchidaceae and Orobanchaceae. Partial parasites of family Loranthaceae are *Korthalsella opuntia* on pine (*Pinus roxburghiana)* (at Kanar), *Scurrula elata* on *Rhododendron arboreum* (at Rathi, Bogudiyar and Mandakani valley), *Viscum album* on pine and toon (*Cedrela toona*) (between Madkot and Baram), and *V. articulatum* (around Gandhura and Madkot). The orchids *Corallorhiza trifida* (a root parasite) and *Gastrodia orobanchoides* (a total plant parasite) were recorded from Martoli grasslands and Bhakuna forest in the Mandakani valley, respectively. Obligate parasitic herbs such as *Orobanche cernua*, *O. epithymum* (at Milam) and *O. solmsii* (at Burphu) on the roots of *Thymus serpyllum* were also recorded.

Insectivorous Flora: Rao (1959) recorded a population of the insectivorous *Pinguicula alpina* from Martoli, but only a small patch was observed during the present survey. Similarly, *Utricularia kumaonense* was recorded around Saba Udiyar near Pilti gad bridge by Pant and Naithani (1981). However, this plant could not be found during our surveys in the valley, indicating the possibility of threats to its survival. Such pressures could prove fatal to a species, particularly with small population size, restricted distribution and smaller niche width (Pandit and Babu 1998).

Orchid Flora: The orchids are one of the largest families of flowering plants in the world, but their distribution is restricted. The family is rich in species diversity, but the population sizes are very small. The reasons for their restricted distribution and small populations are the epiphytic habit of the majority of species and their host preference, though not host specificity. These characteristics make them highly

vulnerable to destruction. The felling of even a single tree destroys many well-established orchid individuals, if not species (Kumar *et al.* 1993).

Goriganga valley harbours a rich wealth of orchid flora. There are nearly 69 species, of which 43 (68%) are epiphytic and only a small number are terrestrial, with a few of these being lithophytes (Table 2). About 55-60% of the species are concentrated in the stretch between Balmara, Baram, Goshi gad, Sera gad and Madkot (600-1,200 m). Epiphytic orchids require high relative humidity for growth and survival. Such a high concentration of orchids in this stretch of Goriganga valley is due to its high relative humidity. The various species are usually seen on pine, banj oak (*Quercus leucotrichophora*), toon, mawa (*Engelhardtia spicata*) and rhododendrons. Many of these have preference for a particular tree species.

The orchid laden trees chiefly occur between 800 m and 1,500 m. Most of these trees colonise boulder deposited fans of various channels draining into Goriganga mainly on its left bank. The right bank offers little scope for such trees and orchids to grow, because of steep, exposed slopes where humidity is very low. The one exception to this is Gandhura Reserve Forest block between Balmara and Bangapani, on the right bank of Goriganga, where the trees support many orchid species. The left bank also has highly humid, suitable habitats for orchids to colonise trees. Notable niches of this 'orchid-tree association' are located mainly in the Daphia Dhura reserve forest block and catchments of Goshi gad, Rachi gad and Sera gad. These niches are narrow, with areas varying from 0.5 to 1.0 sq. km. Such microhabitat and niche specificity makes orchid species vulnerable to extinction in the event of small perturbations in their habitat (Reid and Miller 1989).

TABLE 2
EPIPHYTIC ORCHID SPECIES AND THEIR LOCATIONS IN GORIGANGA VALLEY

Plant species	Area
Acampe rigida	Goshi gad
Aerides multiflorum	Kanar
Bulbophyllum affine	Rachi gad fan
B. careyanum	Rachi gad fan
B. cylindraceum	Rachi gad fan
B. polyrhizum	Daphia Dhura
B. reptans var. *acuta*	Gandhura West
B. secundum	Gandhura West
B. cf. *yokunense*	Daphia Dhura
Coelogyne cristata	Daphia Dhura
C. fimbriata	Daphia Dhura
C. ovalis	Goshi gad
C. stricta	Seraghat
Cymbidium hookerianum	Daphia Dhura
Dendrobium amoenum	Goshi gad
D. denudans	Seraghat
D. herbaceum	Goshi gad
D. porphyrochilum	Daphia Dhura
D. primulinum	Daphia Dhura
Eria excavata	Gandhura
E. flava	Madkot
E. muscicola	Kanar
E. occidentalis	Daphia Dhura

Most of the orchid species represented in the valley have phyto-geographical links with those of northeast Himalayan and Sino-Himalayan region. Seidenfaden and Arora (1982) have pointed out that the orchid flora of Goriganga valley is being depleted rapidly by the destruction of the natural habitat on an exponential scale. This means a total extinction of epiphytic orchid species with an irretrievable loss of genetic diversity. Ever-increasing biotic pressure by deforestation has added to this malady. Seidenfaden and Arora (1982) have strongly recommended this area for the establishment of an orchid sanctuary. Considering the fact that such orchid habitats are few and far between in the northwest Himalaya, this recommendation needs to be urgently considered and implemented.

Terrestrial orchids grow in the valley in areas with high relative humidity (70-85%). Moist, thick oak-rhododendron leaf litter, and the alpine meadows of Martoli and Ralam, where there is adequate water supply, are the natural habitats of terrestrial orchid species. These orchids form the ground vegetation in thick

forests of oak (moru, kharsu and banj) and burans (*Rhododendron arboreum*), and on rocks covered with thick layers of moss. Many orchid species were found between Raragari and Bogudiyar, and many more in the Madkani Reserve Forests and meadows of Panchachuli.

During 1980s, ten new orchid species were reported from this area (Arora 1980), which is indicative of its unexplored biological diversity. In some localities, under intense biotic pressure, it is likely that many species have already become extinct which perhaps were never recorded (Kumar *et al.* 1993). There is also every possibility that biological speciation might be arrested in the changed environment due to increasing biotic pressures. Due to all these negative impacts, a number of orchid species have already become rare (17% of the total species) and have been placed in the Red data book (Nayar and Sastry 1987, 1988, 1990). Orchids are important not only from the botanical point of view but also for their high medicinal and ornamental value. Some, like *Dactylorhiza hatagirea*, are of great medicinal value (Kumar 1986, Chopra *et al.* 1992).

Endangered Flora: Topographical variation and diverse microclimatic conditions have led to the formation of many specialised ecological niches and habitats in the Himalayan highlands (Pandit and Babu 1998). Such niches are inhabited by a number of orchid species in the Goriganga valley. Many new species have been recorded in the valley since 1950 by various workers, described earlier, but these species are represented by small populations in a particular habitat. Many of these taxa are endemic to this region, a common feature of the Himalaya (Kumar 1968).

Deforestation at lower limits, over-grazing and indiscriminate collection of medicinal plants in the higher reaches has led to irretrievable loss in the genetic diversity of the Himalaya (Pandit and Babu 1998). Our observations based on field surveys and earlier studies of Arora (1980), Pant and Naithani (1981) and Malhotra and Balodi (1984 a,b,c,d,e), show that several species are rarely seen in the valley, though these were well represented earlier. Table 3 shows some of the species with an endangered status and restricted distribution in the Goriganga valley.

TABLE 3
PLANT SPECIES OF RESTRICTED/RARE OCCURRENCE IN GORIGANGA VALLEY

Botanical Name	Place restricted to
Aconitum deinorrhizum	Saba Udiyar, 4,000 m
Aconitum heterophyllum	Milam, 3,600 m
Arctium lappa	Ralam, 3,000 m
Briza media	Ralam, 3,400 m
Cassia leschenaultiana	Bui-Ralam, 1,500 m
Christolea himalayensis	Ralam glacier, 4,300 m; Untadhura 4,500 m
Codonopsis ovata	Ralam, 3,000 m
Cornus macrophyllus	On way to Bui, 1,500 m
Cymbidium hookerianum	Daphia Dhura, 1,600 m
Cypripedium himalaicum	Bhujani gad, 3,000 m
Elsholtzia ciliata	Ralam, 2,000 m
Eulophia ucbii	Gargia, 900 m
Falconeria himalaica	Panchachuli, 3,800 m; Munsyari, 2,700 m
Gentiana dentosa	Ralam, 4,000 m
Goodyera fusca	Bazarganga-Ralam, 4,000 m
Hypericum monanthemum	Ralam, 4,000 m
Inula grandiflora	Ralam, 4,000 m
Meconopsis aculeata	Ralam, 3,200 m
Nomocharis nana	Ralam, 3,800 m
Oberonia wightiana	Daphia Dhura, 2,000 m
Orchis habenarioides	Ralam, 3,500 m
Podophyllum hexandrum	Ralam, 3,200 m
Rheum moorcroftiana	Chhirthi, 3,000 m
Saussurea bracteosa	Ralam, 3,600 m
Saxifraga flagellaria	On way to Bui, 1,500 m
Sedum heterodontum	Ralam, 2,900 m
S. hookeri	Ralam, 4,000 m
Smithia ciliata	Bui-Ralam, 1,500 m
Utricularia kumaonense	Pilti bridge-Saba Udiyar, 3,000 m
Vigna capensis	Bui-Ralam, 1,800 m

The valley also provides specific habitats to many plant taxa, which are included in the list of 'Threatened Plants of India' by Jain and Sastry (1980). These endangered or threatened species are: *Aconitum deinorrhizum*, *A. heterophyllum*, *Ajuga brachystemma*, *Carex atrata*, *Cerastium thomsonii*, *Corallorhiza*

trifida, *Cypripedium cordigerum*, *C. himalaicum*, *C. insigne*, *Dactylorhiza hatagirea*, *Ephedra gerardiana*, *Eulophia dabia*, *Gastrodia orobanchoides*, *Gentiana kurroo*, *Herminium duthiei*, *Hoya longifolia*, *Kobresia duthiei*, *Lilium polyphyllum*, *Nardostachys grandiflora*, *Orchis habenarioides*, *Podophyllum hexandrum*, *Polygonatum graminifolium*, *P. verticillatum*, *Rheum australe* and *Viola kunawarensis*.

However, some of these plant species are represented by reasonably good population sizes, albeit in areas less frequented by humans and where biotic disturbances are few. The local villagers have been using these species sustainably over centuries. At places some critically endangered species have been brought under cultivation. One important example is that of *Dactylorhiza hatagirea*, now cultivated by the villagers of Milam (3,380 m). Such local efforts need to be made for other species, and may prove to be the best insurance against their extinction.

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HABITAT ASSOCIATIONS OF BUTTERFLIES IN THE PARAMBIKULAM WILDLIFE SANCTUARY, KERALA, INDIA[1]

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(*With one text-figure*)

Key words: Lepidoptera, diversity, habitats, forest, Kerala, Parambikulam Sanctuary

Habitat associations of 124 butterfly species were determined by analysing species records from five habitat types in the Parambikulam Wildlife Sanctuary, Kerala. The butterflies recorded belonged to 75 genera and 9 families. The families Nymphalidae, Pieridae, Lycaenidae and Satyridae were represented by the maximum number of species. Thirty-three species were present altogether in all the habitat types in the sanctuary. Fifteen species were found to be habitat specific, namely *Papilio buddha*, *Pathysa antiphates*, *Pachliopta pandiyana*, *Pantoporia ranga*, *Pareronia valeria hippia*, *Zipoetis saitis*, *Oriens concinna*, *Virachola perse ghela*, *Zesius chrysomallus* in the evergreen forests and *Ixias marianne*, *I. pyrene*, *Colotis etrida*, *C. danae*, *C. fausta*, *Ypthima ceylonica ceylonica* in the dry deciduous forests. Tropical wet evergreen forests possessed the greatest butterfly diversity in Parambikulam, followed by semi-evergreen and moist deciduous habitats. Significant reduction in butterfly diversity was observed in both dry deciduous habitats and teak plantations. Out of the butterflies recorded, 10 species are narrow endemic to Western Ghats and 18 species have protected status.

Introduction

Among invertebrates, butterflies are suitable for ecological studies, as the taxonomy, geographic distribution and status of many species are relatively well known. These insects, which are mostly phytophagous, serve as primary herbivores in the food chain and are also useful as pollinators of many angiosperms. As many butterflies are good bio-indicators of the environment, they can be used to identify ecologically important landscapes for conservation purposes.

Habitat is the single most important requisite for the proliferation and conservation of a butterfly species (Gilbert and Singer 1975, New 1990-92). All species prefer particular habitats, closely related to their life history: breeding behaviour, larval and adult food resources, etc. In many tropical countries, the rapid destruction of forest wealth has severely affected these butterfly habitats, which are slowly changing into hostile environs (Wells *et al.* 1983). The process has diverse ecological consequences. Many species, which were once common, have become rare. This in turn adversely affects the diversity and abundance of plant species dependent upon them. The identification of important landscapes and their conservation is, therefore, very important.

The butterfly fauna of India is quite well known (Evans 1932, Talbot 1939, 1947, Wynter-Blyth 1957, Larsen 1987, 1988). However, very few studies were conducted in the Western Ghats of Kerala (Fergusson 1891, Fraser 1930, Mathew and Rahmathulla 1993, Palot *et al.* 1997). An attempt is made here to discuss the habitat preferences of butterflies in the Parambikulam Wildlife Sanctuary, an important tropical forest location in Kerala.

Study Area

Parambikulam Wildlife Sanctuary (Fig. 1), a part of the Western Ghats, is situated in the Palghat district, Kerala (76° 35' E and 76° 50' E and between 10° 20' N and 10° 26' N). It opens up as a wide valley between the Nelliyampathy

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ranges in the north and Anaimalais in the south. The Sanctuary has a total area of 270 sq. km and a mean elevation of 600 m above msl. The vegetation is highly complex, a combination of Malabar and Deccan elements (Sebastine and Ramamurthy 1966). Different natural habitats include 1) the west coast tropical evergreen forest, 2) west coast semi-evergreen forest, 3) south Indian moist deciduous forest, and 4) south Indian dry deciduous forest. The man-made habitats include plantations of teak and eucalyptus covering 90 sq. km and 3 sq. km respectively, and small patches of bamboo and reeds. About 28 sq. km of the Sanctuary are occupied by the reservoir. The microhabitats in the Sanctuary include marshy fields or *vayals* and banks of rivers and streams.

Material and Methods

As part of a study on the diversity of a selected group of insects during 1995-97, observations were made by laying belt transects in the Karienshola (evergreen forests), Ammakundu (moist deciduous forests), Thekkady-Keerappady (dry deciduous forests) and Thunacadavu (teak plantations) areas from June 1996 to May 1997. These sites were chosen as representatives of the habitat types in the study area. Each transect was covered twice in a month, between 1000 hrs and 1400 hrs, and observations including the identity of the butterflies encountered were recorded. Sample specimens were collected only if they were needed for identification. Occasional observations were made in other parts of the Sanctuary like Poopara, Orukombankutty, Kuriarkutty, Velayudhankayi, Seechali and Thellikkal.

The identification was done with the help of butterfly collections in the Kerala Forest Research Institute, Peechi, the National Collections at the Zoological Survey of India and the Pusa Collections, Indian Agricultural Research Institute, New Delhi, and with reference to Wynter-Blyth (1957) and D'Abrera (1982, 1985, 1986).

Based on their occurrence in different habitats, the butterflies were categorised as follows:

1. Common (C) - Present in 4 or more habitats
2. Uncommon (UC) - Present in 2-3 habitats
3. Rare (R) - Present in 1 habitat only

Results

Butterflies of 124 species, belonging to 75 genera and 9 families were collected and identified. A list of species with their habitat associations is given in Table 1. Most of the butterflies collected belonged to Nymphalidae (28 species), Pieridae (22 species), Lycaenidae (20 species), Satyridae (16 species) and Papilionidae (15 species).

Butterfly associations in different habitats in the study area are discussed below.

Tropical evergreen forests: In Parambikulam, such forests are seen in Karianshola, Pulikkal, Karappara and Orukomban areas. Small patches of evergreen forests also occur at Karimalagopuram and Shettiwaramalai. Butterflies like *Papilio buddha*, *P. paris*, *Pathysa antiphates*, *Idea malabarica malabarica*, *Vindula erota saloma*, *Parthenos sylvia virens* etc., are seen in the forest canopies of this habitat. The understorey is occupied mostly by shade loving species that are excellent mimics of their surroundings like *Lethe rohria neelgheriensis*, *Ypthima* spp. and *Melanitis* spp. Species like *Cethosia nietneri mahratta*, *Cupha erymanthis maja*, *Catopsilia* spp., *Papilio helenus*, *Tagiades litigiosa* and *Celaenorrhinus ambareesa* are observed in forest clearings formed as a result of tree falls.

Semi-evergreen forests: Semi-evergreen forests appear where evergreen forests merge into moist deciduous forests. The vegetation is a combination of both evergreen and moist deciduous elements. Butterflies present here are common to both evergreen and moist deciduous forests. Species like *Papilio helenus*, *Charaxes*

TABLE 1 (CONTD.)
DISTRIBUTION OF BUTTERFLIES IN VARIOUS HABITATS IN THE STUDY AREA

TABLE 1
DISTRIBUTION OF BUTTERFLIES IN VARIOUS HABITATS IN THE STUDY AREA

Family / Species	*Habitats*				
	EVG	SEV	MDF	DDF	PLN
PAPILIONIDAE					
Graphium sarpedon teredon Felder	*	*	*	*	*
G. agamemnon Linnaeus	*	*	*	*	*
G. doson eleius Fruhstorfer	*	*			
Pachliopta aristolochiae Linnaeus	*	*	*	*	*
P. hector Linnaeus	*	*	*	*	*
P. pandiyana Moore	*				
Papilio polytes thesus Cramer	*	*	*	*	*
P. demoleus Linnaeus	*	*	*	*	*
P. paris tamilana Moore	*	*	*		
P. buddha Westwood	*				
P. helenus Linnaeus	*	*	*		*
P. polymnestor parinda Moore	*	*	*	*	*
P. dravidarum Wood-Mason	*	*			
Pathysa antiphates (Fabricius)	*S				
Troides minos Cramer	*	*	*	*S	*
NYMPHALIDAE					
Cethosia nietneri mahratta Felder	*	*	*		
Charaxes bemardus imna Butler	*	*			
Cirrochroa thais thais Fabricius	*	*	*		
Cupha erymanthis maja Fruhstorfer	*	*	*		
Ariadne ariadne indica Moore	*	*	*	*	*
A. merione merione Cramer	*	*	*	*	*
Polyura athamas athamas Drury	*	*	*		*
Euthalia lubentina arasada Fruhstorfer	*	*	*		
E. aconthea meridionalis Fruhstorfer	*	*	*		
Hypolimnas bolina Linnaeus	*	*	*		*
H. misippus Linnaeus	*	*	*		*
Junonia orithya swinhoei Butler	*	*	*		*
J. lemonias Linnaeus	*	*	*	*	*
J. hierta Fabricius	*	*	*	*	*
J. almana Linnaeus	*	*	*		*
J. atlites Linnaeus	*	*	*		*
J. iphita pluvialis Fruhstorfer	*	*	*	*	*
Kaniska canace viridis Evans	*	*	*		
Moduza procris Cramer	*	*	*		*
Neptis hylas varmona Moore	*	*	*	*	*
N. jumbah jumbah Moore	*	*	*		*
Pantoporia hordonia Stoll	*	*	*		
P. ranga (Moore)	S				
Parthenos sylvia virens Moore	*	*			
Phalanta phalanta Drury	*	*	*		
Tanaecia lepidea miyana Fruhstorfer	*	*	*		
Vanessa cardui Linnaeus	*	*	*		
Vindula erota saloma Swinhoe	*	*	*		*
AMATHUSIIDAE					
Discophora lepida lepida Moore	*	*			
SATYRIDAE					
Lethe rohria neelgheriensis Guerin	*	*	*		*
L. europa Fabricius	*	*			
Melanitis leda leda Drury	*	*	*		*
M. phedima varaha Moore	*	*	*		*
Mycalesis anaxias anaxias Hewitson	*	*	*		*
M. igilia Fruhstorfer	*	*	*		
M. patnia junonia Butler	*	*	*		
M. perseus Fabricius	*	*	*		
M. mineus polydecta Cramer	*	*	*		*
M. visala Moore	*	*	*		
Orsotriaena medus mandata Moore	*	*	*		
Ypthima ceylonica ceylonica Hewitson				*	
Y. baldus madrasa Evans	*	*	*	*	*
Y. philomela Linnaeus	*	*	*		
Y. huebneri Kirby	*	*	*	*	*
Zipoetis saitis Hewitson	*				
ACRAEIDAE					
Acraea terpsicore Linnaeus	*	*	*	*S	
DANAIDAE					
Danaus genutia genutia Cramer	*	*	*	*	*
D. chrysippus chrysippus Linnaeus	*	*	*	*	*

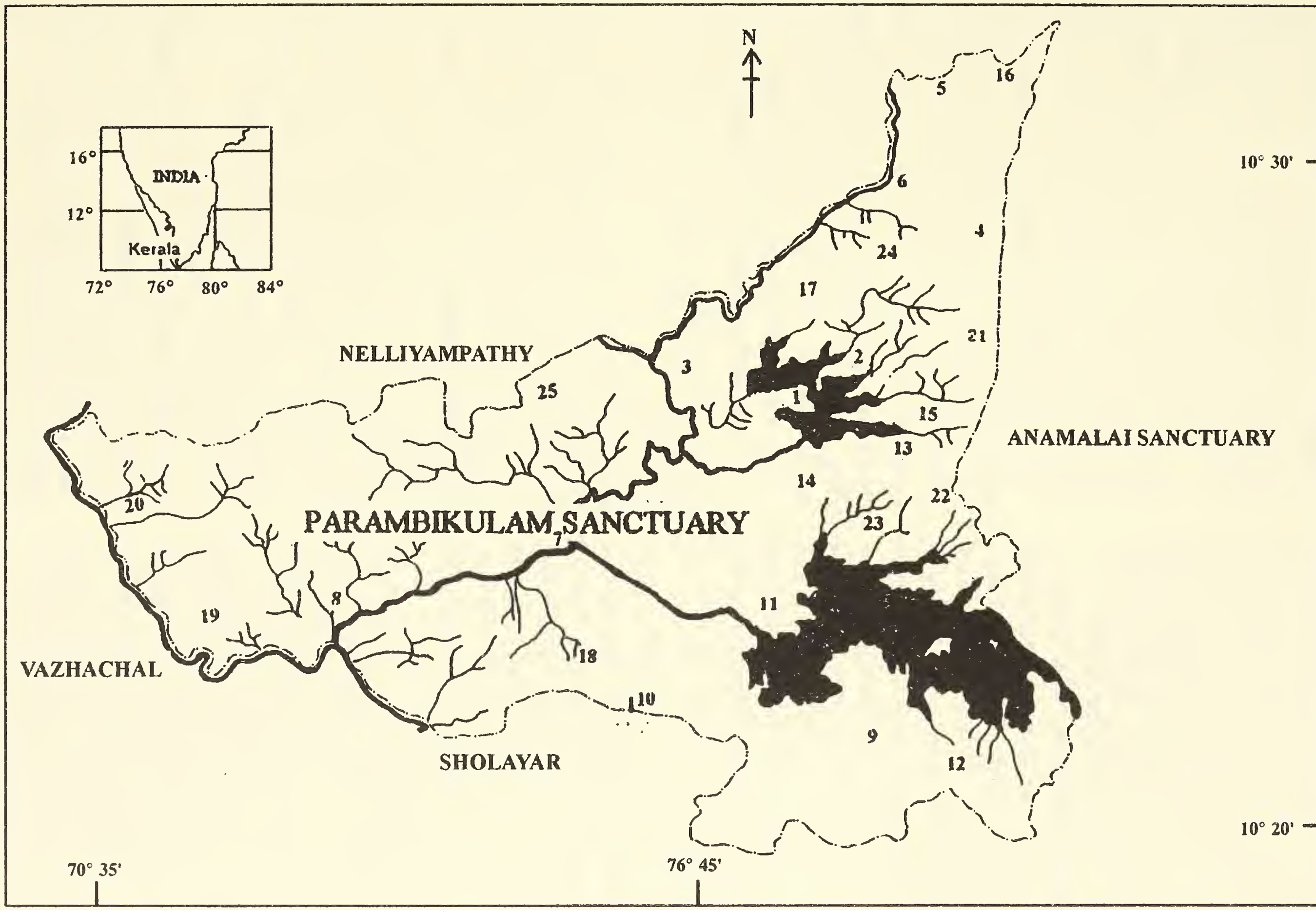
TABLE 1 (CONTD.)
DISTRIBUTION OF BUTTERFLIES IN VARIOUS HABITATS IN THE STUDY AREA

Family / Species	EVG	SEV	MDF	DDF	PLN
Euploea core core Cramer	*	*	*	*	*
Idea malabarica malabarica Moore	*	*			
Parantica aglea aglea Cramer	*	*	*	*	*
P. nilgiriensis Moore	*	*	*		
Tirumala limniace leopardus Butler	*	*	*	*	*
PIERIDAE					
Appias libythea libythea Fabricius	*	*	*	*	*
A. lyncida latifascia Moore	*	*	*	*	*
A. albina darada Felder	*	*			
A. indra shiva Swinhoe	*	*	*		
Anapheis aurota Fabricius	*	*	*		*
Catopsilia pomona pomona Fabricius	*	*	*	*	*
C. pyranthe Linnaeus	*	*	*	*	*
Cepora nerissa phryne Fabricius	*	*	*	*	
C. nadina remba Moore	*	*			
Colotis fausta (Olivier)				*	
C. etrida Boisduval				*	
C. danae Fabricius				*	
Delias eucharis Drury	*	*	*	*	*
Eurema laeta laeta Boisduval	*	*	*	*	*
E. hecabe Linnaeus	*	*	*	*	*
E. blanda Boisduval	*	*	*	*	*
E. brigitta rubella Wallace	*	*	*		*
Hebomoia glaucippe australis Butler	*	*	*	*	*
Ixias pyrene sesia Linnaeus				*	
I. marianne Cramer				*	
Leptosia nina nina Fabricius			*	*	
Pareronia valeria hippia Fabricius	*S				
LYCAENIDAE					
Caleta caleta Hewitson	*	*	*		*
Castalius rosimon (Fabricius)	*	*	*	*	*
Celastrina lavendularis Moore	*	*	*		
Cheritra freja (Fabricius)	*	*	*		
Chilades pandava pandava Horsfield	*	*	*		
Curetis dentata dentata Moore	*	*	*		

TABLE 1 (CONTD.)
DISTRIBUTION OF BUTTERFLIES IN VARIOUS HABITATS IN THE STUDY AREA

Family / Species	EVG	SEV	MDF	DDF	PLN
Virachola perse ghela (Fruhstorfer)	S				
Discolampa ethion vavasanus Fruhstorfer	*	*	*		*
Euchrysops cnejus cnejus Fabricius	*	*	*		*
Jamides alecto (Felder)	*	*	*		*
J. celeno (Cramer)	*	*	*	*	*
J. bochus bochus Cramer	*	*			
Loxura atymnus Cramer	*	*	*		
Neopithecops zalmora dharma Moore	*	*			
Spindasis vulcanus vulcanus Fabricius	*	*	*		
S. schistacea schistacea Moore	*	*	*		
Talicada nyseus nyseus Guerin	*	*			
Udara akasa Horsfield	*	*	*		
Zesius chrysomallus Hubner	*S				
Zizina otis decreta Butler	*	*	*		*
HESPERIIDAE					
Badamia exclamationis Fabricius	*	*	*		
Celaenorrhinus leucocera Kollar	*	*			
C. ambareesa Moore	*	*	*		*
Hasora chromus chromus Cramer	*	*	*		
Iambrix salsala luteipennis Plotz	*	*	*		
Oriens concinna El.	*				
Odontoptilum angulata Felder	*	*	*		
Potanthus pava pava Fruhstorfer	*	*	*		
Pelopidas subochracea subochracea Moore	*	*			
Spialia galba Fabricius	*	*	*		
Tagiades litigiosa Moschler	*	*	*		*
Taractrocera ceramas ceramas Hewitson	*	*	*		
Telicota ancilla bambusae Moore	*	*	*		*

Abbreviations: EVG - Evergreen; SEV - Semi-evergreen; MDF - Moist Deciduous Forest; DDF - Dry Deciduous Forest; PLN - Teak Plantation; S - Single observation during the entire study period



1. Thunacadavu; 2. Sungam; 3. Thellickal; 4. Karianshola; 5. Thekkadi; 6. Elathodu; 7. Kuriarkutty; 8. Orukombankutty; 9. Poopara; 10. Karimalagopuram; 11. Parambikulam; 12. Muduva colony; 13. Vengolimala; 14. Pillakkal; 15. Seechalipallam; 16. Keerappadi; 17. Ponnamudi; 18. Kottayali; 19. Muthuvarachal; 20. Puliyalapara; 21. Anappady; 22. Vengoli; 23. Veyakkadamudi; 24. Padippara; 25. Thoothampara.

Fig.1: Map of Parambikulam Wildlife Sanctuary showing study sites

bernardus imna, *Cirrochroa thais thais*, *Tanaecia lepidea miyana*, *Polyura athamas athamas*, *Phalanta phalanta*, *Hypolimnas* spp., *Neptis* spp. and *Junonia* spp. are commonly found here. Besides a few species of *Papilio paris tamilana*, *Vindula erota saloma* and *Parthenos sylvia virens* are also occasionally sighted. The understorey species are more or less same as in the evergreen forest habitat.

Moist deciduous forests: In the Sanctuary, such forests cover 60 sq. km area. They are mostly encountered along the ridges and lower slopes.

Several species of butterflies which are generally common in the study area like *Neptis hylas varmona*, *Ariadne ariadne indica*, *Papilio demoleus*, *Euploea core core*, *Tirumala limniace leopardus*, *Junonia* spp., *Pachliopta* spp. etc are encountered in this habitat. Species like *Charaxes bernardus imna*, *Polyura athamas athamas*, *Appias lyncida latifascia*, and *Tanaecia lepidea miyana* are occasionally sighted here during June-July.

The forest understorey species showed remarkable seasonal variation in this habitat. Species like *Eurema hecabe*, *E. blanda*, *Ypthima baldus madrasa* and *Y. huebneri* are seen throughout the year. During June-July species like *Melanitis leda leda*, *M. phedima varaha*, *Mycalesis igilia*, *I. patnia junonia* and *M. perseus* can also be sighted.

Dry deciduous forests: This type of forest is seen in the Thekkady-Keerappady region, and constitutes only 15 sq. km. The climate is extremely dry with very low rainfall. The forests are mainly thorny bush and scrub jungles.

These forests are seen only in a small patch, and the butterfly fauna here is unique and varied. Canopy species include *Danaus chrysippus*, *Hebomoia glaucippe australis* and *Cepora nerissa phryne*, along with *Catopsilia* spp., *Junonia* spp. and *Appias* spp. A single specimen of *Troides minos* was also sighted in January.

This habitat harbours the most distinctive understorey fauna in the Sanctuary. Species like *Ixias marianne*, *I. pyrene sesia*, *Colotis fausta*, *C. danae*, *C. etrida* and *Ypthima ceylonica ceylonica* are confined to this habitat. Species like *Leptosia nina nina*, *Ypthima baldus madrasa*, *Y. huebneri* and *Eurema* spp. are also common.

Teak plantations: The teak plantations here are in a state of reversion. Deciduous species like *Cassia fistula*, *Cordia dichotoma*, *Butea monosperma*, *Grewia tiliaefolia* and *Randia* spp. appear, intermingled with teak trees.

The butterfly community is a mosaic, with species from moist deciduous and semi-evergreen forests dominating. Species like *Neptis jumbah jumbah*, *Vindula erota saloma*, *Papilio helenus*, *Tanaecia lepidea* were recorded during the wet months. Understorey fauna also shows similar affinity to moist deciduous forests, with species like *Melanitis leda leda*, *Mycalesis mineus polydecta*, *Ypthima* spp. and *Eurema* spp.

***Vayals* or marshes**: Butterflies which prefer bright sunlight and open areas inhabit this habitat. Danaid butterflies like *Tirumala limniace leopardus*, *T. septentrionis dravidarum*, *Parantica aglea aglea*, *P. nilgiriensis* and Nymphalids like *Junonia atlites*, *J. iphita pluvialis*, *Euploea core core* and Pierids like *Eurema* spp. and *Appias* spp. are common. Aggregations of mud puddling butterflies of the species *Appias indra shiva*, *A. libythea libythea*, *Cepora nadina remba*, *Graphium sarpedon teredon* and *Jamides* spp. are characteristic of *vayals*. Small scale population build-up of *Tirumala limniace leopardus*, *T. septentrionis dravidarum*, *Parantica aglea aglea*, *Danaus chrysippus*, *D. genutia genutia* and *Euploea core core* were also seen in summer.

Banks of rivers and streams: Two major river valleys, the Parambikulam and the Sholayar are present in the Sanctuary. These two rivers converge at Orukombankutty and flow into the main Chalakkudy river. Species like *Kaniska canace viridis*, *Graphium sarpedon teredon*, *Caleta caleta*, *Castalius rosimon*, *Discolampa ethion vavasanus* and *Jamides* spp. were recorded

from the banks of these rivers and streams.

Protected and endemic butterflies: Eighteen species recorded in this study come under the protected category as per the Indian Wildlife Act, 1972 (Table 2). Among them, the Lycaenid *Castalius rosimon rosimon*, the Nymphalid *Hypolimnas misippus*, and the Papilionid *Pachliopta hector* come under Schedule I of the Act. The rare species include the Satyrid *Mycalesis igilia*, the Hesperid *Odontoptilum angulata*, the Danaids *Parantica nilgiriensis* and *Idea malabarica malabarica*. The Papilionid *Papilio dravidarum* and the Lycaenid *Zesius chrysomallus* are considered very rare. Out of the 23 species, which are endemic to different biogeographic regions, 10 species are narrow endemics of Western Ghats and another 10 are endemic to south India and Sri Lanka, while the remaining 3 are endemic to Sri Lanka and the Indian subcontinent.

Discussion

The butterflies recorded from Parambikulam represent all the major families, with Nymphalidae, Pieridae, Lycaenidae, and Satyridae and Papilionidae dominating, followed by Hesperidae and Danaidae. Acraeidae and Amathusiidae are represented by only one species each. Altogether, 124 butterflies were collected and their habitat preferences recorded. Of them, 10 species are narrow endemic to Western Ghats. Eighteen species have protected status as per the Indian Wildlife Act, 1972 (Anon., 1990).

Some interesting and rare species such as *Discophora lepida*, *Pathysa antiphates*, *Papilio buddha*, *Pantoporia ranga*, *Pareronia valeria hippia* and *Charaxes bernardus imna* were recorded. The only representative of Acraeidae in south India, *Acraea terpiscore* has also been recorded from the Parambikulam forests.

With regard to the distribution, evergreen forest was found to be the most species-rich habitat (117 species). This was followed by semi-evergreen forests (108 species) and moist deciduous forests (95 species). Teak plantations were found to be inhabited by 57 species, which means that there is substantial reduction in butterfly diversity in this altered environment. Dry deciduous forest habitat, which covers only 5.26% of the sanctuary area, harbours the least number (41 species).

Parambikulam contains a number of different habitats and climate zones, as diverse in form and structure as wet evergreen forests and dry deciduous forests, which may account for the high species richness for butterflies. The number of species collected from Parambikulam (124) is higher than that from Silent Valley (100) (Mathew and Rahmathulla, 1993) and Periyar Tiger Reserve (119) (Palot *et al.*, 1997). Endemism in the fauna is also higher in Parambikulam (23 species) than in Silent Valley (13 species) and Periyar (19 species).

Among the butterflies recorded, 60 species are considered common in the sanctuary. These include 33 species observed in all the habitats studied, and 27 species present only in the four habitats. 49 species are considered uncommon as their distribution is limited to 2 or 3 habitats. The distribution of 15 species restricted to a particular habitat are considered rare, which include 9 species observed exclusively in evergreen forests viz., *Papilio buddha*, *Pathysa antiphates*, *Pachliopta pandiyana*, *Pantoporia ranga*, *Pareronia valeria*, *Zipoetis saitis*, *Oriens concinna*, *Virachola perse* and *Zesius chrysomallus*. Six species viz., *Ixias marianne*, *I. pyrene*, *Colotis etrida*, *C. fausta*, *Ypthima ceylonica* are observed exclusively in the dry deciduous habitat. Most of the butterflies observed in the *vayals* and the banks of rivers and streams are common species.

Significant variation was observed in habitat preference between the butterflies in the forest understorey and forest canopy. Forest understorey species like *Lethe rohria*, *Ypthima ceylonica*, *Ixias pyrene*, *Colotis fausta* showed

TABLE 2
LIST OF RARE AND ENDEMIC BUTTERFLIES RECORDED FROM PARAMBIKULAM

FAMILY/SPECIES	STATUS	ENDEMISM
Papilionidae		
Troides minos Cramer		Western Ghats
Pachliopta hector Linnaeus	Protected, Schedule I	South India & Sri Lanka
P. pandiyana Moore		Western Ghats
Papilio buddha Westwood	Protected, Schedule II	Western Ghats
P. dravidarum Wood-Mason	Very rare	Western Ghats
P. polymnestor parinda Moore		Peninsular India & Sri Lanka
Pieridae		
Appias libythea libythea Fabricius	Protected, Schedule IV	
Appias lyncida latifascia Moore	Protected, Schedule II	
A. albina darada Felder	Protected, Schedule II	Western Ghats
A. indra shiva Swinhoe	Protected, Schedule II	
Cepora nadina remba Moore	Wettest rainforests	
Delias eucharis Drury		South India & Sri Lanka
Nymphalidae		
Cirrochroa thais thais Fabricius	Only in wettest rainforests	South India & Sri Lanka
Cethosia nietneri mahratta Felder	Only in wettest rainforests	South India & Sri Lanka
Euthalia lubentina (Cramer)	Protected, Schedule IV	
Hypolimnas misippus Linnaeus	Protected, Schedule I	
Neptis jumbah jumbah Moore	Protected, Schedule I	
Parthenos sylvia Moore	Protected, Schedule II	
Tanaecia lepidea miyana Fruhstorfer	Protected, Schedule II	
Pantoporia ranga Moore	Protected, Schedule II	
Amathusiidae		
Discophora lepida lepida Moore	Protected, Schedule II	South India & Sri Lanka
Satyridae		
Mycalesis anaxias anaxias Hewitson	Protected, Schedule II	
M. igilia Fruhstorfer	Rare	Western Ghats
M. patnia junonia Butler		South India & Sri Lanka
Ypthima ceylonica ceylonica Hewitson		South India & Sri Lanka
Zipoetis saitis Hewitson	Protected, Schedule II	Western Ghats
Acraeidae		
Acraea terpsicore Linnaeus		Sri Lanka & Indian Subcontinent
Danaidae		
Parantica nilgiriensis Moore	Rare	Western Ghats
Idea malabarica malabarica Moore	Rare	Western Ghats
Lycaenidae		
Castalius rosimon rosimon Fabricius	Protected, Schedule I	
Euchrysops cnejus cnejus Fabricius	Protected, Schedule II	
Spindasis vulcanus vulcanus Fabricius		Sri Lanka & Indian Subcontinent
S. schistacea schistacea Moore		South India & Sri Lanka
Udara akasa Horsfield		Sri Lanka & Sri Lanka
Zesius chrysomallus Hubner	Very rare	Sri Lanka & Indian Subcontinent
Hesperidae		
Odontoptilum angulata (Feld.)	Rare	
Oriens concinna Elwes	Protected, Schedule IV	Western Ghats

remarkable habitat specificity compared to forest conopy species like *Cirrochroa thais*, *Papilio demoleus*, *Delias eucharis*, and *Hebomoia glaucippe*. This may be the reason why canopy butterflies (barring a few species) are common in the Sanctuary.

The habitat association of butterflies discussed here is based on the observed distribution in various habitats. One of the reasons for a species' association with a particular habitat could be the presence of its host plants. For example, the papilionid *Pachliopta pandiyana* recorded from the evergreen forest habitat can survive only on the habitat-specific evergreen shrub, *Thottea siliquosa* (Lam.) Hou (Aristolochiaceae). Similar ecological data for other butterfly species could help to interpret their habitat associations precisely.

The presence of a rich butterfly fauna in the Parambikulam Wildlife Sanctuary is indicative of the diverse habitats in the Sanctuary, which help in the proliferation and abundance of butterfly species. Holloway *et al.* (1992) observed that conversion of forests to plantation and other man-induced disturbances lead to reduction in the diversity of lepidopterans, both in species richness and in taxonomic and biogeographic quality. Parambikulam, with a variety of vegetation types, climatic zones, and remarkable endemism, must be given top priority for the conservation of its rich biodiversity.

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GROWTH PATTERN OF MANGROVES IN THE GULF OF KUTCH[1]

H. S. Singh[2]

(*With three text-figures*)

Key words: Mangroves, Gulf of Kutch, *Avicennia marina,* growth pattern

In the past, mangroves were tall, over 14 m in height in Gujarat State. Eleven core species were recorded in the literature, but during an extensive survey of the tidal forests of Gujarat from 1994 to 1999, only eight species, with the dominant *Avicennia marina*, have been encountered. Most mangroves are now shrubby, with an average height of 2 m, while *A. marina* attains moderate height along creeks and towards the sea. Heights of dominant trees in the Gulf of Kutch were normally 5 to 7 m, rarely exceeding 9 m in western mangroves. Stump and stem analysis of *A. marina* on Pirotan Islands (Marine National Park, Jamnagar) and in western mangroves (Kutch), revealed that four growth rings were formed annually, as against two rings in trees, especially conifers.

Extreme summer and winter are not suitable for photosynthesis of *A. marina* in the Gulf of Kutch, and are non-growth periods. Studies in other parts of the world indicate that photosynthesis of *A. marina* ceases below 13 °C and above 35 °C, with peak production between 20 °C and 27 °C. Two nongrowth periods alternating with the growth periods explain the formation of more than two rings a year.

Introduction

The Gulf of Kutch (22°15' N to 23°40' N and 68°20' E to 70°40' E), Gujarat State, is located in western India. Jamnagar and Rajkot districts of Saurashtra to the south and Kutch district in the north constitute the boundary of the Gulf. The Gulf has an area of 7,350 sq. km, the east-west length is about 170 km and width 175 km at the mouth. The southern part of the Gulf has a network of 42 islands (*bets*) with coral reefs and rich marine life.

The average annual rainfall in the region ranges from 400 to 600 mm, with about 14 rainy days, mostly from the SW monsoon, which breaks over Saurashtra and Kutch in the end of June and continues to the end of September. Air temperature ranges from 7.8 °C in January to 44.8 °C in May. The water temperature generally varies from 15 °C to 35 °C. However, local increase above 35 °C is recorded in summer in isolated water pools in the intertidal area. Evapo-transpiration in Kutch is very high and annual ratio of precipitation to evapo-transpiration ranges between 0.3 and 0.5. The humidity in Kutch varies from 50% during November-December to 80% during SW monsoon (Singh *et al.* 1999). There is no perennial river in Saurashtra and Kutch, and discharge of rainwater through seasonal monsoon rivers is reduced due to the construction of dams.

Tide amplitude in the Gulf is recorded varying from 3.0 m to 6.0 m. Water salinity in the mangrove creek normally varies from 37 ppt to 44 ppt and still higher salinity is recorded in summer in pools of water in the hyper-saline zone. Low rainfall, extreme temperature, salinity and tide amplitude are limiting factors for the development of mangroves (Singh 1999). The pH value of creek water ranges between 7.7 and 9.1 in western mangroves (Singh *et al.* 1999). Average pH value of the mangrove soil at Pirotan was 8.4 (8.1 to 8.9). Average organic carbon was 0.43%, whereas available phosphorus and potash content was 33.3 kg/ha and 4.0 kg/ha respectively (Singh 1999).

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Mangroves in Gujarat: Gujarat State has notified a total area of 1,324 sq. km in Kutch, Jamnagar and Rajkot districts in the Gulf of Kutch as mangrove forests, locally called *Cher*. Using remote sensing technology, the Forest Survey of India (FSI), Dehra Dun in 1997 and 1999, estimated a mangrove cover of about 991 and 1,031 sq. km respectively in Gujarat, second only to the Sunderbans in West Bengal. The Gujarat Ecological Education and Research (GEER) Foundation, Gandhinagar made an independent study in 1999 using IRS LISS-111 data of 1998, and interpreted forest cover on a scale of 1:50,000. This provided an accurate estimate of 938.4 sq. km (874.4 sq. km in the Gulf of Kutch) mangrove cover. Western mangroves in Abdasa and Lakhpat taluka, known as Indian deltaic mangroves, are the largest tidal forests in Gujarat. Part of the mangroves in and around Kori creek were destroyed by the cyclone that hit Gujarat and the coast of Pakistan in May 1999.

Floral diversity and height of mangroves decreases as one moves away from the equatorial region, and hence diversity of mangroves in Gujarat is poorer than in other mangroves of the country. Thirteen core mangrove species have been recorded on the western coast of India. Eleven species, belonging to seven genera and five families were recorded in Gujarat (Chavan 1985, Kothari 1991), nine of them in the Gulf of Kutch. *Avicennia officinalis*, *A. marina*, *A. alba*, *Aegiceras corniculatum*, *Ceriops tagal*, *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Sonneratia apetala*, *Acanthus ilicifolius*, *R. apiculata* and *B. cylindrica* were species recorded in Gujarat. Singh (1999) could record only eight species in Gujarat as *R. apiculata*, *Bruguiera gymnorrhiza* and *B. cylindrica* were not encountered in the two years study. At present, only seven core species of mangroves grow in the Gulf of Kutch.

Avicennia marina dominates the forests of Gujarat, constituting the majority of mangrove trees in the State, which are shrubby with low height, but *A. marina* attains good height along the creek and seaward.

Methods

Growth pattern of mangroves in the Gulf of Kutch was not studied in the past, except that the height of mangroves was recorded in some areas. To understand tree development pattern at good sites in the Gulf, the literature including records of the Forest Department were studied, and height of trees was measured at a few sites while the author was serving as Conservator of Forests, Marine National Park. Tree diameter and height relationship, and heights and corresponding diameters of *Avicennia marina* were recorded on Pirotan, its neighbouring *bets* and in western mangroves in Kutch. Studies on *A. marina* by the Gujarat Institute of Desert Ecology (GUIDE), Bhuj on western mangroves were also consulted (Singh *et al.* 1999).

Girth at breast height (gbh) and height of *Avicennia* trees were measured in landlocked mangroves at Shravan Kavadiya to understand growth pattern in the past. While carrying out this exercise, distinct growth rings were observed on a tree stump. Thus providing an idea to conduct stump and stem analysis of trees to understand growth pattern. Stem and stump analysis was hence, done at Pirotan Island and in western mangroves near Siyadinar. 15 trees at Pirotan and 5 trees in western mangroves were cut for this purpose. Thousands of tall trees had died in the cyclones of 1998 and 1999, only dead trees were cut, at 20 to 50 cm above ground level, depending on the tapering of the stump. Four radii were drawn on the stump and each radius was measured at intervals of 10 growth rings, and the average diameter was estimated.

Results and Discussion

Mangrove trees with a height of 14 m have been recorded in the past (Chavan 1985).

Landlocked mangroves at Shravan Kavadiya in fringes of Banni grassland are tall. This land was part of the Gulf in the historic past. A small patch of old mangroves in about 0.7 ha survived till the cyclone that occurred in June, 1998. About 36 trees with tops broken still survive on the site. The average height of dead trees measured about 18.0 m in 1999. This reveals that mangroves in the Gulf were extensive and taller than those in existing forests. Various studies indicated that geomorphological and climatic changes had made an impact on mangroves in the region.

Presently in Gujarat, mangroves are shrubs with an average height of 2 m, but they attain good height along the creek and seawards. *Rhizophora mucronata* occurs only on the islands in the Marine National Park; its average height is 3.5 m. *Ceriops tagal* and *Aegiceras corniculatum* are also shrubs about 1.2 to 1.4 m high; they occur only on the *bets* in the Park. The height of the tallest *Ceriops tagal* at Pirotan was 2.9 m. *Acanthus ilicifolius* is a shrub growing in the estuarine areas of south Gujarat. *Sonneratia apetala* occurs in the estuary of the Tapti, where trees exceed 6 m height in restricted areas.

Avicennia alba is a small tree, while *A. marina* is the tallest tree in the mangroves in Gujarat. Old trees of *A. marina* were observed in 1994, and most of them had broken tops. Their height was between 5.0 and 7.2 m on Chhad and Zindra *bet*. Good *cher* forest, regenerated after destruction of old mangroves on Pirotan and Bhensbid, had an average top height of 4.4 m (3.6 to 5.4 m) in 1994, which increased to 5.3 m (4.0 to 6.0 m) in 1999. Measurements of dominant trees at Pirotan revealed that a plantation of 1983 attained top height of 3.2 m in 15 years.

Singh (1999), conducted surveys of western mangroves at five sites (Medi creek, Laki creek, Jakhau, Mundra, Kori creek), and reported that density of trees (height of 75 cm) ranged from the lowest 792 trees/ha at Laki to a maximum of 1900 trees/ha at Kori creek. Tree height in the area ranged from 0.75 to 10.0 m. Trees at Medi post were taller, with a mean height of 3.7 m and shorter at Jakhau with a mean height of 2.2 m. In all the five stations, heights in the range of 1.6 to 3.0 m were greater in number followed by 1.0 to 1.5 and 3.0 to 4.5 m classes.

The tallest trees with heights of about 10.0 m were recorded at Carissod creek. Trees up to 9.0 m were measured in Kav creek in the forest of Medi post. Many trees in the height class of 6.0 to 7.5 m were measured in Kori, Medi and Laki creeks. At Mundra and Jakhau, tree height did not exceed 6.0 m. The maximum number of trees above 6.0 m was recorded in the forest of Medi post. Mean gbh in the western mangroves was estimated from 31 cm at Mundra to 37 cm at Medi. Maximum and minimum gbh recorded was 15 cm at Navinal creek and 2.25 m at Laki creek. Trees with gbh of 21 to 40 cm predominated at all sites, followed by the 41 to 60 cm class (Singh *et al*., 1999). Average height and gbh of 17 tall (dominant) trees in Jakhau forest were estimated at 5.3 m (4.0 and 6.9 m) and 43.6 cm (27 and 66 cm), respectively (Singh 1999).

Stump and Stem Analysis: As mentioned earlier, growth rings on stumps of *Avicennia marina* are as distinct as those of any coniferous tree growing in the temperate region. The author, along with the Conservator of Forests, Marine National Park, his staff, and scientists of GEER Foundation, initiated an exercise on one of the *bets* (Pirotan) in the Park. On small stumps, number of rings (light or dark) was exceptionally high, which made the investigators sceptical. Trees were cut in an area which was regenerated after 1982 to confirm findings. There were no mangroves on the site before the plantation in 1983. Study revealed that the number of growth rings (dark or light) was almost double the age of plantation. This was confirmed from other areas also. This finding appeared to have no explanation. Local watchmen and fishermen

informed us that the *cher* forests remain green and luxuriant during monsoon and in late winter or early summer. They become dull and pale green at the peak of winter and summer. This probably means that there are two good growth periods in a year, with two non-growth periods. Mangroves in similar climatic conditions in Australia and America respond to temperature stress by decreasing their structural complexity i.e. decreased tree height, leaf area index, leaf size and increased tree density (Lugo and Zucca, 1977). Mangroves growing in the environment prevailing in the Gulf are less tolerant to low temperature. McMillan (1971) reported that high water temperature could also be a limiting factor. Hutching and Saenger (1987) concluded in their study that for Australian mangrove species, growth ceases below 15 °C with peak production occurring between 20 °C and 27 °C. *Avicennia marina*, classed by them as a cool temperate species, commences leaf production above 12 °C with peak production at around 20 °C. MacNae (1963), found that *A. marina* occurs in southern Africa in the areas where mean air temperature does not fall below 13 °C. Various studies have shown that for most mangrove species, photosynthesis declines sharply above 35 °C (Pernetta, 1993). In the Gulf of Kutch, temperature difference is very high. In summer, air temperature increases above 40 °C and soil temperature above 35 °C. Thus, growth (photosynthesis) of *Avicennia* species in the Gulf remains very low during summer (May-June) due to high temperature, increased salinity and high water current and also during extreme winter, (December-January) due to low temperature. On the basis of the above, it appears that there are four periods in a year differentiating distinct growth seasons.

The above analysis explains that there are two non-growth periods in mangroves in the Gulf, i.e. extreme summer and winter. This finding is not conclusive, but forms the basis for further study on the growth pattern of *A. marina* in the subtropical region. It is assumed here that four growth rings are formed annually. The growth pattern of *A. marina* on the basis of stump and stem analysis is discussed below.

Data on 15 trees at Pirotan and 5 trees in western mangroves have been analysed. Trees were cut at a height of 20 to 50 cm above ground level, depending on stem form near the ground. The growth pattern of *Avicennia* trees at good sites along the creek or seawards is given in Tables 1, 2 and 3, and Figs 1, 2 and 3. These show that *Avicennia marina* attains 4.9 m height and about 31 cm girth at stump in 20 years at Pirotan. The growth pattern has been extrapolated up to 22 years tree age, but could not be done beyond this due to non-availability of old trees in the area. This analysis is site and situation specific and may differ from other areas.

Mangroves in Jakhau (Siyadinar) are some of the good tidal forests in Kutch. Large numbers of big trees died in the cyclone in May 1999. Five dead trees were cut to carry out stump analysis. Two dark and two light rings were considered as one year's growth. Trees were cut at 50 cm from the ground and rings were counted along four radii on each stump. Table 2 gives the results of graphic analysis of average age and corresponding diameter. Stump analysis revealed that *A. marina* has an average diameter of 11.0 cm at stump (50 cm above ground) in 25 years and 22.5 cm in 50 years near the creek.

Conclusion

The Gulf of Kutch is not a true tropical region, and climatic conditions are not ideal for mangroves as in the Sundarbans and the Andaman and Nicobar Islands. Most of the mangroves in the Gulf of Kutch and other parts of Gujarat are shrubby, but *A. marina* attains moderate height at good sites near the creek and seawards. The top canopy of mangrove trees is usually damaged as a result of high winds and cyclones. Although mangroves in the Gulf were

TABLE 1
GROWTH PATTERN OF *AVICENNIA*

Age in years	Girth at stump (cm)
2	NA
4	5.0
6	6.5
8	9.5
10	15.5
12	21.0
14	24.0
16	26.5
18	29.5
20	31.0
22	32.0

TABLE 2
GROWTH PATTERN OF *AVICENNIA*

Age in years	Height (cm)
2	60
4	90
6	120
8	180
10	270
12	350
14	390
16	430
18	470
20	490
22	510

TABLE 3
GROWTH PATTERN OF *AVICENNIA*

Age in years	Ave. diameter at stump (cm)
5	2.0
10	4.1
15	6.5
20	8.7
25	11.0
30	13.0
35	16.0
40	18.7
45	20.5
50	22.5
55	24.0
60	25.5
65	26.5

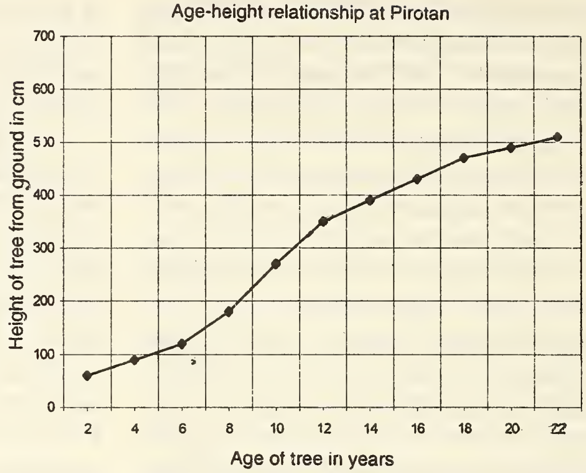

Fig. 1: Growth pattern of *Avicennia*

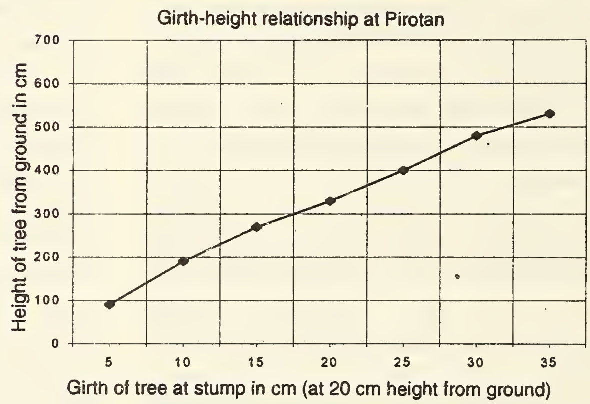

Fig. 2: Growth pattern of *Avicennia*

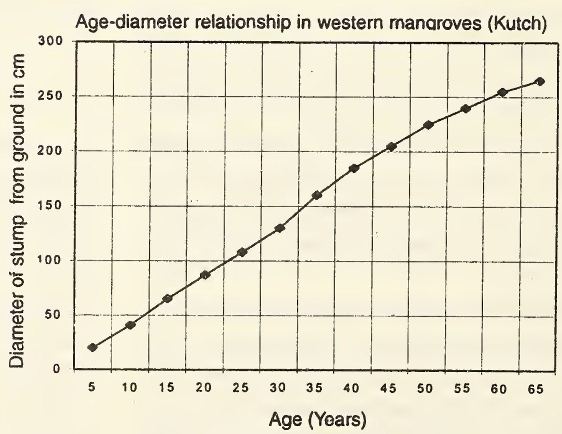

Fig. 3: Growth pattern of *Avicennia*

tall in the past, their height now rarely exceeds 9.0 m. On an average, the diameter of *A. marina* increases 0.45 cm (0.4 cm to 0.5 cm) per year at good sites in the Gulf of Kutch. This study revealed that distinct rings are formed as a result of change in temperature and other climatic conditions. Photosynthesis is at a maximum during monsoon and moderate summer, and is low or almost absent in extreme winter and summer. Light and dark rings on stumps are certainly related to growth variation. Unlike two-ring formation in a year in most trees, especially in temperate forests, there are four growth rings in *A. marina*. Findings in this paper add to our knowledge of mangrove development in the Gulf of Kutch, laying the basis for further studies.

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THE STATUS OF MONGOOSES (FAMILY: HERPESTIDAE) IN RUHUNA NATIONAL PARK, SRI LANKA[1]

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(*With two text-figures*)

Key words: Mongooses, Herpestidae, *Herpestes*, carnivores, Ruhuna National Park

Three species of mongoose occur in Ruhuna National Park, namely *Herpestes edwardsii*, *H. smithii* and *H. vitticollis*. They are mostly solitary and diurnal carnivores that inhabit a variety of habitats ranging from moist riverine forests to arid open grasslands. Ninety-six individuals were recorded from 86 observations, during a transect study carried out between October 1991 and September 1993, in which a total of 34 days were spent in Block I (141 sq. km) of the Park. The most conspicuous and abundant species is the ruddy mongoose (*H. smithii*), while the grey mongoose (*H. edwardsii*) is rare. The stripe-necked mongoose (*H. vitticollis*) is the largest species associated with moist areas. The mongooses were found to be active throughout the day, but had two peaks of activity: a major one in the morning (0800 hrs) and a minor one in the late evening (1700 hrs). It is estimated that there could be at least a minimum of 370 ruddy mongoose, 100 stripe-necked mongoose and 30 grey mongoose in Block I, giving a crude density of 2.6, 0.7 and 0.2 per sq. km respectively. The sympatric occurrence of these three species of small carnivores underlines the ecological richness and diversity of the Park.

Introduction

Of the 12 species of mongoose that belong to the genus *Herpestes* worldwide, 4 occur in Sri Lanka, namely the Indian grey mongoose (*Herpestes edwardsii*), ruddy mongoose (*H. smithii*), Indian brown mongoose (*H. fuscus*) and stripe-necked or badger mongoose (*H. vitticollis*). All but the brown mongoose occur in the Ruhuna National Park. Mongooses were at one time included under the family Viverridae, but subsequently assigned a separate family, Herpestidae by Pocock (1939). The presence of distinct herpestine and viverrine fossils in the lower and mid-Miocene of Europe indicates that these two groups might have diverged from one another very early (Petter 1969). Herpestids are long-bodied, short-legged, terrestrial carnivores characterized by highly developed anal scent glands (Corbet and Hill 1992). They are never blotched or spotted, and their coats are normally grizzled and coarse in texture (Kingdon 1977). Another peculiarity is that in all Asian *Herpestes*, the males have one chromosome less than the females: 2n = 35 in males, and 36 in females (Fredga 1972). Petter (1969), on the basis of tooth structure has shown the genus *Herpestes* to be the least modified from the primitive miacid-type carnivore from which the viverrids and herpestids had evolved.

Mongooses occupy a variety of habitats ranging from densely forested hills to open arid areas. They usually live in holes in the ground or hollow trees. They seldom climb trees (Lekagul and McNeely 1977). They are known to prey on snakes, even venomous ones such as the cobra (*Naja naja*). While mongooses are less sensitive than most mammals to snake venom, they are not completely immune to it (Prater 1971). Mongooses being predominantly diurnal, are a common feature of the wildlife seen in the national parks in Sri Lanka. Nevertheless, there has been no attempt at serious research on mongoose in Sri Lanka, and much of what is known about their biology is still derived from the observations of Eisenberg and Lockhart (1972), and Phillips (1984). Hence, this

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preliminary study was undertaken to obtain information on the diversity, abundance and activity of mongooses in the Ruhuna National Park, given the need to know their current status, if measures aimed at their conservation are to be appropriate and effective.

Study Area

The observations on mongooses were carried out in Block I (141 sq. km) of the Ruhuna National Park (1,268 sq. km), situated on the southeast coast of Sri Lanka (Fig. 1). Block I is characterized by a large number of freshwater tanks (man-made ponds and lakes), and brackish lagoons. The main vegetation cover is woody, mostly thorn-scrub, where the canopy is below 5 m in height, but forest trees occur in clumps within the scrub, and as continuous cover inland from the coast (Mueller-Dombois 1972). The Park lies in a transition zone between the single wet season experienced on the east coast and the double peak of precipitation found along the south coast of the island (IUCN 1990). The mean annual temperature is 27 °C, and the main dry season extends from May to September. The Park receives less than 1,000 mm of rain per year. For details regarding the flora and fauna of the Park see Balasubramaniam *et al.* (1980), and Santiapillai *et al.* (1981).

Material and Methods

Block I has a good network of motorable roads, designed to take visitors past all the major water-holes and grazing grounds. Between October 1991 and September 1993, 34 days were spent observing the mongooses in the Park. Observations were carried out twice a day between 0630 hrs and 1830 hrs, along the network of roads, starting from the Palatupana bungalow near the Park entrance to the Yala bungalow in the north, along the coast, passing most of the water-holes and grasslands and from there back to Palatupana via Heenwewa through largely scrub and forest. An area of approximately 14 sq. km was intensively searched for mongooses (Fig. 1). Most of the animals were recorded as they crossed the road. In open grasslands, and around water-holes, they were recorded from larger areas, due to clear visibility. At every sighting, the species was identified and its number, locality, habitat, time and activity recorded. All observations were made with the naked eye or a pair of 8 x 40 binoculars, from a vehicle driven at about 7 km per hour.

Results and Discussion

A total of 94 mongooses were recorded during 86 observations. Of the three species of mongoose in the Park, the grey mongoose (*Herpestes edwardsii*) was the least common with only 3 individuals, recorded on two occasions (Table 1). Of the other two species, 13 stripe-necked or badger mongoose (*H. vitticollis*) were observed on 12 occasions. The ruddy mongoose (*H. smithii*) was the most conspicuous and numerically abundant species in the Park with 78 recordings. It is surprising that the brown mongoose (*H. fuscus*) which is so common along the southwest coast of Sri Lanka up to Tangalle, does not occur in the Park.

Herpestes smithii

The ruddy mongoose identified easily in the field by its black-tipped, upwardly pointed tail, is one of the most successful and adaptable small carnivores in the Ruhuna National Park. It occupies a wide variety of habitats such as thorn-scrub, forest, coastal sand dunes, and the 'villu' grasslands. While in Wilpattu National Park it is reportedly associated with permanent water (Eisenberg and Lockhart 1972), in Ruhuna National Park, it inhabits a variety of habitats and is not exclusively associated with water-

Fig. 1: Map of Block I of Ruhuna National Park (RNP), Sri Lanka showing the location of the main water-holes.

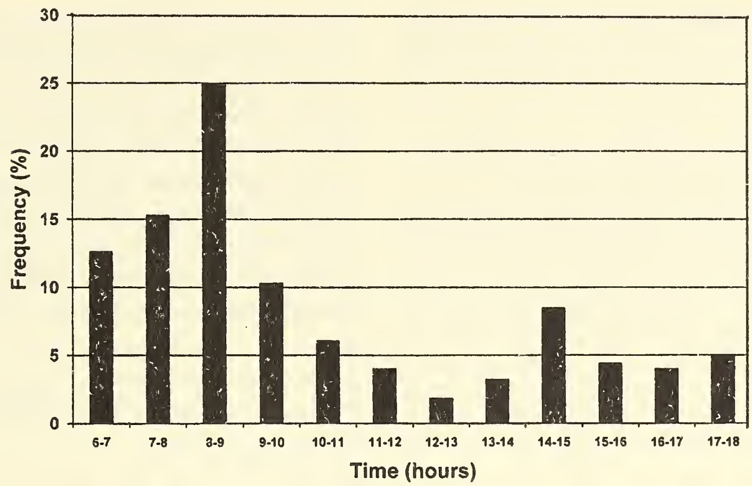

Fig. 2: Frequency of mongooses sighted per unit time period at different hours.

TABLE 1
SPECIES DIVERSITY AND ABUNDANCE OF MONGOOSES IN RUHUNA NATIONAL PARK

Species	*H. edwardsii*	*H. smithii*	*H. vitticollis*	Total
October 1991	-	3	1	4
January 1992	-	18	2	20
March 1992	2	12	5	19
June 1992	-	4	-	4
January 1993	1	7	1	9
March 1993	-	14	4	18
April 1993	-	2	-	2
September 1993	-	18	-	18
Total	3	78	13	94

holes. Observations point to its essentially solitary nature; 92% of the animals observed were solitary, while pairs accounted for 8%. The pairs observed were adult males and females. No young were seen during the survey. The ruddy mongoose appears to have a restricted home range, within which it usually follows the same route. The size of its range depends on habitat and prey availability. In East Africa, Taylor (1970) estimated the range of the slender mongoose (*H. sanguineus*) to be about 1 sq. km, while in Hawaii, Tomich (1969) estimated the range of the male and female small Indian mongoose (*H. auropunctatus*) to be 2.0 and 0.5 sq. km respectively. The ruddy mongoose is an effective and audacious predator that forages alone, never in a group. For food and feeding habits see Phillips (1984) and Prater (1971).

Herpestes vitticollis

The stripe-necked or badger mongoose, readily identified by its characteristic black neck-stripe, is the largest of all mongooses in Asia. Essentially a forest animal, rarely encountered far from water. All the observations of this species were made in moist areas and in the vicinity of the River Menik Ganga. It is the most solitary among all species of mongoose. The only stable social unit consists of the mother and her offspring. Although the badger mongoose can be encountered at any time of the day, it appears to be most active in the early hours between 0700-0900 hrs. It is catholic in its diet. According to Phillips (1984), it takes not only small mammals and large prey like the black-naped hare (*Lepus nigricollis*), mouse deer (*Tragulus meminna*) and jungle fowl (*Gallus lafayetti*), but also freshwater crabs, frogs, and fish that occur in swamps or slow moving streams. Ramachandran (1985) has recorded this

mongoose scavenging a tiger kill. The mongoose can be seen examining the river banks and other damp areas for crabs and frogs (Table 2).

TABLE 2
FOOD PREFERENCES OF THE MONGOOSES IN RUHUNA NATIONAL PARK

Food items	*H. smithii*	*H. edwardsii*	*H. vitticollis*
root	-	+	-
fruits	-	+	-
berries	-	+	-
carrion	+	+	-
termites	-	+	-
beetles	-	+	+
grubs	-	+	+
snails	+	-	-
lizards	+	+	+
snakes	+	+	+
ground birds	+	+	+
bird's eggs	+	+	+
jungle fowl	-	-	+
rats	+	+	+
mice	+	+	+
shrew	+	+	+
mouse deer	-	-	+
hare	-	-	+
freshwater crabs	-	-	+
freshwater fish	-	-	+
frogs	-	-	+
Total	9	14	15

Source: Phillips (1984), and information from Park authorities (+ indicates an item eaten by the species)

Herpestes edwardsii

The grey mongoose is identified by its silver-grey, pepper-and-salt speckled pelage and the whitish tip (never black) of its long tail. It is associated with open areas, cultivated fields, grasslands and scrub, but not forest (Prater 1971). It is mostly solitary and diurnal. Active, particularly in the early mornings between 0800 and 0900 hrs, it tends to use tracks and is often seen crossing the roads. The normal gait is a quick trot. A cautious animal, it moves constantly, examining the surroundings for food. It is often seen in close proximity to termite mounds, which are plentiful across much of the Park. Termite adults are not an important food item, but larval forms are preferred on account of their high fat content. The grey mongoose appears to rely on larger prey such as ground birds and their eggs, lizards, small snakes, insects, grubs and to a lesser extent, fruits, berries and roots (Phillips 1984). In India, it has been observed to chase the hare (*Lepus nigricollis*) and run away with a dead cattle egret (*Bubulcus ibis*) that had been left to lure Indian foxes out of the den (Johnsingh 1978). It will kill and devour any small snake. It was also observed digging into water buffalo dung in search of beetles and termites.

Activity pattern

Mongooses are solitary predators that hunt by day and by night, and can be seen crossing the road at any time of the day. Fig. 2 represents the frequency of mongooses (all three species) sighted per unit time period at different hours. 25% of the sightings were between 0800 and 0900 hrs, while over 50% of the sightings were made between 0600 and 0900 hrs. They were mostly encountered in and around the water-holes. About 80% of the observations in the Park were made in the 'villu' grasslands around the water-holes.

The mongooses are diurnal in Ruhuna National Park. There are essentially two peaks of activity: a large one in the morning at about 0800 hrs and another small one late in the evening about 1700 hrs. These two peaks of activity refer to foraging and hunting; mongooses hunt actively during early morning and late evening. The early morning activity coincides with the basking time of most small reptiles, such as lizards and snakes. The period of diurnal activity is interrupted by one or more short resting periods. In southwest Spain, Palomares and Delibes (1993) found that the Egyptian mongoose (*H. ichneumon*), which is also diurnal devotes about 75% of its daytime to resting. At mid-day, most of the mongooses retreat into the forest or

near the river to escape the heat. The usual sleeping and resting areas are the termitaries and other natural crevices in the rocky areas of the Park which afford protection from the largest predator, the leopard (*Panthera pardus*), and from inclement weather. Given that underground dens and thickets fulfill both requirements, Palomares and Delibes (1993) recommend that habitats having such dens and thickets should be protected to guarantee the conservation of mongooses.

Number and Density

On the basis of the restricted home ranges of mongooses, and their association with water-holes, we estimate that at least 37 ruddy mongoose, 10 badger mongoose and 3 grey mongoose reside within the area covered by the transect, which amounts to roughly 14 sq. km, bearing thorn-scrub vegetation that is typical of the Park. This translates into a population of 370 ruddy mongoose, 100 badger mongoose, and 30 grey mongoose, in Block I (141 sq. km) of the Ruhuna National Park, giving crude density values of 2.6, 0.7 and 0.2 per sq. km for the three species respectively. These density values must be treated with extreme caution, as they were based on the animals observed in the transect, and not on any rigorous mark-release-recapture study. In any case, they represent the minimum crude densities of the three species in the Park. In Puerto Rico, the density of the small Indian mongoose (*H. auropunctatus*) in sugarcane plantations (where it was introduced to kill snakes) became as high as 250 per sq. km (Piementel 1955). At such high density, the mongoose became a pest. But in the wild, mongooses do not occur in high densities. Eisenberg and Lockhart (1972), observed the ruddy mongoose (*H. smithii*) to be the most numerous species in Wilpattu National Park, in northwest Sri Lanka. The same appears to be true for Block I of the Ruhuna National Park, in southeast Sri Lanka. It is interesting to note that although both Parks support only three species of mongoose, they occur in different combinations: *H. smithii*, *H. edwardsii* and *H. fuscus* in Wilpattu, and *H. smithii*, *H. edwardsii* and *H. vitticollis* in Ruhuna. The stripe-necked mongoose replaces the brown mongoose in Ruhuna. Furthermore, while *H. fuscus* is the rarest of the three species in Wilpattu (Eisenberg and Lockhart, 1972), in Ruhuna, *H. edwardsii* is the least common.

Conclusion

The biological richness and diversity of Block I of Ruhuna National Park is reflected by the number of carnivore species it supports. The fact that three species of mongoose are sympatric in the area, points to the existence of a much larger community of animals supporting them.

Of the three species, the most abundant and conspicuous is the ruddy mongoose. The three species are catholic in their diet and appear to have restricted home ranges. All three species appear active during the day and may extend their activity period to the evenings as well. The three species of mongoose are legally protected in Sri Lanka. The principal threat to them comes from the use of toxic agro-chemicals in farming areas that surround the protected areas. Strictly controlled use of such poisons in and around livestock areas, particularly near wildlife reserves, is needed. At the same time, in areas of high predation by mongooses, the losses should be offset by some sort of compensation by the Department of Wildlife Conservation to ensure that man and mongoose coexist peacefully.

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AVIAN SPECIES INVOLVED IN POLLINATION AND SEED DISPERSAL OF SOME FORESTRY SPECIES IN HIMACHAL PRADESH[1]

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Key words: Pollination, *Bombax ceiba* Linn., *Celtis australis* Linn., seed eaters, Pycnonotidae

Studies on avian species involved in pollination and seed dispersal of some forestry species have been carried out since 1994 in the University campus at Nauni, Solan in Himachal Pradesh. During the study, 31 species of birds belonging to 13 families and 4 orders were recorded interacting with 28 species of trees and shrubs. Of the 31 species of birds recorded, 10 were involved in pollination alone, another 10 contributed to pollination and seed dispersal, while 8 species were involved in seed dispersal only. The remaining 3 species, all parakeets, were found to be seed eaters, though two of them were involved in pollination. Our study revealed that relative abundance of bulbuls (Family: Pycnonotidae) was very high, as nectarivores and as seed dispersal agents, followed by mynas (Family: Sturnidae). The members of the family Pycnonotidae are, therefore, important agents in cross pollination and also in seed dispersal.

Introduction

The 1,200 species of birds found in India constitute an important component of our agro- and forest ecosystems. It is well recognised now that birds play an important role in shaping our economy. Realising the importance of birds for an agricultural country like India, Sálim Ali (1936) laid the foundation of economic ornithology. The literature on economic ornithology as reviewed by Mehrotra and Bhatnagar (1979), and recently by Dhindsa and Saini (1994), suggest that the role of birds in relation to agriculture and horticulture has received the attention of many workers (Mason and Lefroy 1912, Hussain and Bhalla 1937, Mukherjee 1969-76, Toor and Ramzan 1974, Mathew *et al.* 1980, Narang and Lamba 1984 and Narang 1986). Scientists working under the All India Network Programme (AINP) on Agricultural Ornithology have also contributed to the subject. However, the role of birds in pollination and seed dispersal of various forestry species has received little attention from Indian ornithologists so far. The literature on pollination by birds was reviewed by Subramanya and Radhamani (1993). According to them, the role of birds in pollination was studied by Singh 1929, Ali 1932, Kannan 1980 and Davidar 1985. Several publications on birds feeding on wild fruits are available (Ali 1931, Faruqui *et al.* 1960, Howe and Estabrook 1977, Shahabuddin 1993, Balasubramanian 1995, 1996 and Rajsekhar 1995).

This work was aimed to (i) study the bird species involved in the pollination of *Bombax ceiba* Linn. and the seed dispersal of *Morus alba* Linn., *Celtis australis* Linn. and a shrub *Coriaria nepalensis* Wall., and (ii) to record in general the bird species involved in pollination and seed dispersal of some important forest trees/shrubs.

Material and Methods

The study initiated in 1994 was carried out at the Nauni campus of the University of Horticulture and Forestry, Solan (30° 50' N, 77° 11' E and 1,250 m above msl). The campus is spread over an area of 550 ha, most of it under agroforestry ecosystems. Approximately 200 species of trees and shrubs have been recorded from the campus so far (Sindhi 1996).

The study area was visited twice a week in the morning for one hour and tree-bird

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interactions recorded using 7x50 field binoculars. Ten trees each of *Bombax ceiba* (Linn.), *Morus alba* Linn. and *Celtis australis* Linn. were identified as study sites. Record of birds with remarks, whether feeding on nectar or fruit, was maintained for each tree/shrub and for each visit. Data pertaining to bird species diversity per tree/shrub and their relative abundance was also recorded.

Results and Discussion

A total of 31 species of birds (Table 1) belonging to 13 families and 4 orders were recorded interacting with 28 species of trees and shrubs (Table 2). Out of the 31 species of birds recorded, 10 were involved in pollination alone, 10 contributed to pollination and seed dispersal, while 8 species were agents of seed dispersal only (Table 1). The slatyheaded parakeet *Psittacula himalayana* was recorded to be a seed eater, whereas the Alexandrine parakeet *Psittacula eupatria* and plum-headed parakeet *Psittacula cyanocephala,* though contributing to cross pollination, did not contribute to seed dispersal, and were found to be seed eaters.

Birds as pollinators: During the present study, 22 species of birds were recorded sipping nectar from 11 tree species, 2 shrubs and 2 ornamental plants (Table 3). While doing so, the bill and forehead of the bird gets smeared with pollen. The birds feeding on nectar, therefore, contribute to the cross pollination of trees, shrubs and ornamental plants visited by them.

A total of 58 bird species belonging to 16 families and 4 orders have been recorded as flower birds (Subramanya and Radhamani 1993). During this study, 9 more have been recorded as pollinators, taking the total to 67. Nearly 70% of the bird species frequented more than one species of plant for nectar (Table 3).

The semal tree *Bombax ceiba* Linn., which flowers during March-April, was the most preferred tree species. A total of 19 species of birds were observed sipping nectar on semal (Table 4), followed by coral tree *Erythrina indica* Lamk., which attracted 11 bird species. *Woodfordia floribunda* Salisb., which flowers during April-May, was visited by 8 bird species. During this period, the forehead of oriental white-eye *Zosterops palpebrosus* was found smeared with brown pollen grains, the result of its feeding on the nectar of *Woodfordia floribunda* Salisb., during which the pollen was brushed on to the forehead. Another ornithophilous tree *Butea monosperma* (Lamk.) Taub. was visited by 5 bird

Table 1

BIRD COMMUNITY VISITING FOREST SPECIES FOR NECTAR (N) AND FRUITS (F)

Bird species		N/F
Common Name	Scientific Name	
Alexandrine parakeet	*Psittacula eupatria*	N & F (P)
Plum-headed parakeet	*Psittacula cyanocephala*	N & F (P)
Slatyheaded parakeet	*Psittacula himalayana*	F(P)
Asian koel	*Eudynamys scolopacea*	F
Great barbet	*Megalaima virens*	F
Bluethroated barbet	*Megalaima asiatica*	F
Eurasian golden oriole	*Oriolus oriolus*	F
Spot-winged starling	*Saroglossa spiloptera*	N
Chestnut-tailed starling	*Sturnus malabaricus*	N
Common myna	*Acridotheres tristis*	N&F
Jungle myna	*Acridotheres fuscus*	N&F
Redbilled blue magpie	*Urocissa erythrorhyncha*	N&F
Large-billed crow	*Corvus macrorhynchos*	N&F
Rufous treepie	*Dendrocitta vagabunda*	F
Grey treepie	*Dendrocitta formosae*	F
Himalayan bulbul	*Pycnonotus leucogenys*	N&F
Redvented bulbul	*Pycnonotus cafer*	N&F
Black bulbul	*Hypsipetes madagascariensis*	N&F
Jungle babbler	*Turdoides striatus*	N&F
Redbilled leiothrix	*Leiothrix lutea*	F
Rufous sibia	*Heterophasia capistrata*	N
Flycatcher	*Muscicapa* sp.	N
Grey-hooded warbler	*Seicercus xanthoschistos*	N
Dark-throated thrush	*Turdus ruficollis*	F
Great tit	*Parus major*	N
Purple sunbird	*Nectarinia asiatica*	N
Crimson sunbird	*Aethopyga siparaja*	N
Oriental white-eye	*Zosterops palpebrosus*	N&F
House sparrow	*Passer domesticus*	N
Russet sparrow	*Passer rutilans*	N
Common rosefinch	*Carpodacus erythrinus*	N&F

F(P) : Seed eater

TABLE 2
SPECIES OF PLANTS VISITED BY BIRDS FOR NECTAR (N) OR FRUITS (F)

Plant species	Family	N/F
Bignonia venusta Ker-Gawl.	Bignoniaceae	N
Bombax ceiba Linn.	Bombacaceae	N
Ehretia acuminata R.Br.	Boraginaceae	F
Bauhinia variegata Linn.	Caesalpiniaceae	N
Coriaria nepalensis Wall. (shrub)	Coriariaceae	F
Xylosma longifolium Clos. (off season flowering plant)	Flacourtiaceae	N
Woodfordia floribunda Salisb. (shrub)	Lythraceae	N
Hibiscus mutabilis Linn. (ornamental plant)	Malvaceae	N
Azadirachta indica A. Juss.	Meliaceae	F
Ficus palmata Forsk.	Moraceae	F
Ficus religiosa Linn.	Moraceae	F
Morus alba Linn.	Moraceae	F
Eucalyptus globulus Labill	Myrtaceae	N
Butea monosperma (Lamk.) Taub.	Papilionaceae	N
Erythrina indica Lamk.	Papilionaceae	N
Ougenia oojeinensis (Roxb.)	Papilionaceae	N
Punica granatum Linn.	Punicaceae	N
Crataegus crenulata Roxb.	Rosaceae	F
Prunus cerasoides D. Don. (off season flowering plant)	Rosaceae	N
Prunus sp.	Rosaceae	N
Pyrus pashia Buch.-Ham. ex D. Don	Rosaceae	N N& F
Rosa moschata Hook. (shrub)	Rosaceae	F
Rubus ellipticus Smith (shrub)	Rosaceae	F
Leptodermis lanceolatus Wall. ex DC (shrub)	Rubiaceae	N
Osyrus arborea (Wall.) ex DC (shrub)	Santalaceae	F
Solanum nigrum Linn.	Solanaceae	F
Grewia optiva Drumm. ex Burr.	Tiliaceae	F
Celtis australis Linn.	Urticaceae	F

species. The small bird community of this species could be attributed to its small population in the study area.

Kannan (1980) discovered that flower nectar is an important item of the sunbird's diet. During the present study, purple sunbird *Nectarinia asiatica,* a summer migrant in the University campus, was seen to visit 9 species of bird flowers. The crimson sunbird *Aethopyga siparaja* was recorded frequenting two species of ornamental plants, namely *Hibiscus mutabilis* Linn., *Bignonia venusta* Ker-Gawl., a climber and *Woodfordia floribunda* Salisb., a shrub. Crimson sunbirds were, however, partial to the nectar of ornamental plants, which they were observed sipping through the regular flower opening, and had also adopted a short cut method to reach the nectar. Even the unopened flowers of *Hibiscus mutabilis* Linn. were robbed of their nectar by these birds.

A few species of trees/shrubs flower during September-November, when the breeding season of birds is over. The Oriental white-eye *Zosterops palpebrosus,* a specialized nectar-feeder, was observed visiting *Leptodermis lanceolatus* Wall., a shrub that flowers after the birds' breeding season. It also visited *Prunus cerasoides* D. Don., a plant flowering outside the breeding period, for nectar. The Himalayan bulbul *Pycnonotus leucogenys,* a non-specialized nectar-feeder, was also recorded frequenting the plants of *Prunus cerasoides* D. Don. for nectar during its non-breeding period in September-October.

Kannan (1980) has termed the Nectariniidae (sunbirds), Zosteropidae (white-eyes), Irenidae (leafbirds) and Dicaeidae (flowerpeckers) as specialized nectar-feeders among Indian birds. Out of these, sunbirds and white-eyes are the important flower birds (i.e. flower visitors) of the study area (Table 3). Leafbirds are not represented in the study area, and flowerpeckers are rare during the flowering period. Amongst the non-specialized nectar-feeders, bulbuls (Pycnonotidae) especially the Himalayan bulbul *Pycnonotus leucogenys,* were found to be the prominent nectar-feeders, followed by mynas and starlings (Sturnidae).

Birds as seed dispersal agents: As per our study, 21 bird species belonging to 10 families were observed feeding on the fruits of 14 plant species, which include 5 shrubs and a herb (Table 5). Out of the 21 avian species observed feeding on fruits, 3 species of parakeets were found to be seed eaters and did not help in seed dispersal. The two resident species of parakeets i.e. *Psittacula eupatria* and *Psittacula cyanocephala* were recorded as feeding on and rendering

TABLE 3
FLOWER BIRDS OF THE STUDY AREA AND PLANT SPECIES VISITED BY THEM

Bird species		Plant species visited
Common Name	Scientific Name	
Alexandrine parakeet	*Psittacula eupatria*	*Bombax ceiba* Linn.
Plum-headed parakeet	*Psittacula cyanocephala*	*Bombax ceiba* Linn.
Spot-winged starling	*Saroglossa spiloptera*	*Bombax ceiba* Linn. *Woodfordia floribunda* Salisb.
Chestnut-tailed starling	*Sturnus malabaricus*	*Bombax ceiba* Linn. *Butea monosperma* (Lamk.) Taub. *Woodfordia floribunda* Salisb.
Common myna	*Acridotheres tristis*	*Bombax ceiba* Linn. *Erythrina indica* Lamk. *Butea monosperma* (Lamk.) Taub. *Eucalyptus globulus* Labill.
Jungle myna	*Acridotheres fuscus*	*Bombax ceiba* Linn. *Erythrina indica* Lamk. *Butea monosperma* (Lamk.) Taub.
Large-billed crow	*Corvus macrorhynchos*	*Bombax ceiba* Linn. *Erythrina indica* Lamk.
Redbilled blue magpie	*Urocissa erythrorhyncha*	*Bombax ceiba* Linn.
Himalayan bulbul	*Pycnonotus leucogenys*	*Bombax ceiba* Linn. *Woodfordia floribunda* Salisb. *Erythrina indica* Lamk. *Prunus cerasoides* D. Don. *Prunus* sp. *Xylosma longifolium* Clos.
Redvented bulbul	*Pycnonotus cafer*	*Bombax ceiba* Linn. *Erythrina indica* Lamk.
Black bulbul	*Hypsipetes madagascariensis*	*Bombax ceiba* Linn. *Erythrina indica* Lamk.
Jungle babbler	*Turdoides striatus*	*Bombax ceiba* Linn. *Erythrina indica* Lamk. *Butea monosperma* (Lamk.) Taub.
Rufous sibia	*Heterophasia capistrata*	*Bombax ceiba* Linn. *Erythrina indica* Lamk.
Flycatcher	*Muscicapa* sp.	*Bombax ceiba* Linn. *Woodfordia floribunda* Salisb.
Grey-hooded warbler	*Seicercus xanthoschistos*	*Ougenia oojeinensis* (Roxb.)
Great tit	*Parus major*	*Bombax ceiba* Linn.
Purple sunbird	*Nectarinia asiatica*	*Bombax ceiba* Linn. *Woodfordia floribunda* Salisb. *Erythrina indica* Lamk. *Butea monosperma* (Lamk.) Taub. *Pyrus pashia* Buch.-Ham. ex D. Don *Prunus* sp. *Bauhinia variegata* Linn. *Punica granatum* Linn. *Bignonia venusta* Ker-Gawl.
Crimson sunbird	*Aethopyga siparaja*	*Hibiscus mutabilis* Linn. *Bignonia venusta* Ker-Gawl. *Woodfordia floribunda* Salisb.

TABLE 3 (CONTD.)
FLOWER BIRDS OF THE STUDY AREA AND PLANT SPECIES VISITED BY THEM

Bird species		Plant species visited
Common Name	Scientific Name	
Oriental white-eye	*Zosterops palpebrosus*	*Bombax ceiba* Linn.
		Erythrina indica Lamk.
		Woodfordia floribunda Salisb.
		Ougenia oojeinensis (Roxb.)
		Prunus cerasoides D. Don.
		Prunus sp.
		Pyrus pashia Buch.-Ham. ex D. Don
		Leptodermis lanceolatus Wall.
House sparrow	*Passer domesticus*	*Bombax ceiba* Linn.
		Erythrina indica Lamk.
Russet sparrow	*Passer rutilans*	*Bombax ceiba* Linn.
Common rosefinch	*Carpodacus erythrinus*	*Woodfordia floribunda* Salisb.

TABLE 4
RELATIVE ABUNDANCE OF BIRDS ON FOUR PLANT SPECIES

Bird species		Relative abundance (%)			
Common Name	Scientific Name	1	2	3	4
Alexandrine parakeet	*Psittacula eupatria*	3.22	-	*.656	-
Plum-headed parakeet	*Psittacula cyanocephala*	6.17	-	*5.45	-
Asian koel	*Eudynamys scolopacea*	-	2.08	-	-
Bluethroated barbet	*Megalaima asiatica*	-	-	4.19	-
Eurasian golden oriole	*Oriolus oriolus*	-	-	-	3.17
Spot-winged starling	*Saroglossa spiloptera*	1.46	-	-	-
Chestnut-tailed starling	*Sturnus malabaricus*	2.05	-	-	-
Common myna	*Acridotheres tristis*	2.66	-	26.18	23.80
Jungle myna	*Acridotheres fuscus*	2.71	14.58	-	7.93
Redbilled blue magpie	*Urocissa erythrorhyncha*	1.14	8.33	-	-
Large-billed crow	*Corvus macrorhynchos*	11.20	-	16.36	-
Grey treepie	*Dendrocitta formosae*	-	-	7.27	-
Himalayan bulbul	*Pycnonotus leucogenys*	21.47	20.83	21.44	20.63
Redvented bulbul	*Pycnonotus cafer*	5.18	16.66	2.72	3.17
Black bulbul	*Hypsipetes madagascariensis*	14.34	16.66	4.03	6.34
Jungle babbler	*Turdoides striatus*	5.13	-	-	11.11
Redbilled leiothrix	*Leiothrix lutea*	-	2.08	-	-
Rufous sibia	*Heterophasia capistrata*	3.25	-	-	-
Rufous treepie	*Dendrocitta vagabunda*	-	-	5.75	14.28
Flycatcher (unidentified)	???	0.61	-	-	-
Darkthroated thrush	*Turdus ruficollis*	-	4.16	-	-
Great tit	*Parus major*	4.61	-	-	-
Purple sunbird	*Nectarinia asiatica*	4.14	-	-	-
Oriental white-eye	*Zosterops palpebrosus*	3.07	-	-	9.52
House sparrow	*Passer domesticus*	1.53	-	-	-
Russet sparrow	*Passer rutilans*	6.06	-	-	-
Common rosefinch	*Carpodacus erythrinus*	-	14.58	-	-

1. *Bombax ceiba* Linn. 2. *Morus alba* Linn. 3. *Celtis australis* Linn. 4. *Coriaria nepalensis* Wall.
*Both the species of parakeets are seed eaters

TABLE 5
AVIAN SPECIES INVOLVED IN SEED DISPERSAL

Bird species		Plant visited
Common Name	Scientific Name	
*Alexandrine parakeet	*Psittacula eupatria*	*Celtis australis* Linn.
*Plum-headed parakeet	*Psittacula cyanocephala*	*Celtis australis* Linn.
*Slatyheaded parakeet	*Psittacula himalayana*	*Pyrus pashia* Buch.-Ham. ex D. Don.
Asian koel	*Eudynamys scolopacea*	*Morus alba* Linn.
Great barbet	*Megalaima virens*	*Ficus religiosa* Linn.
Bluethroated barbet	*Megalaima asiatica*	*Ficus religiosa* Linn.
		Celtis australis Linn.
Eurasian golden oriole	*Oriolus oriolus*	*Coriaria nepalensis* Wall.
Common myna	*Acridotheres tristis*	*Celtis australis* Linn.
		Ficus religiosa Linn.
		Ficus palmata Forsk.
		Coriaria nepalensis Wall.
		Solanum nigrum Linn.
Jungle myna	*Acridotheres fuscus*	*Morus alba* Linn.
		Ficus religiosa Linn.
		Coriaria nepalensis Wall.
Redbilled blue magpie	*Urocissa erythrorhyncha*	*Morus alba* Linn.
		Rubus ellipticus Smith
Large-billed crow	*Corvus macrorhynchos*	*Celtis australis* Linn.
Rufous treepie	*Dendrocitta vagabunda*	*Celtis australis* Linn.
		Coriaria nepalensis Wall.
Grey treepie	*Dendrocitta formosae*	*Celtis australis* Linn.
Himalayan bulbul	*Pycnonotus leucogenys*	*Celtis australis* Linn.
		Morus alba Linn.
		Coriaria nepalensis Wall.
		Azadirachta indica A. Juss.
		Ficus religiosa Linn.
		Grewia optiva Drumm. ex Burr.
		Ficus palmata Forsk.
		Crataegus crenulata Roxb.
Redvented bulbul	*Pycnonotus cafer*	*Morus alba* Linn.
		Coriaria nepalensis Wall.
		Grewia optiva Roxb.
		Osyrus arborea (Wall.) ex DC
		Celtis australis Linn.
Black bulbul	*Hypsipetes madagascariensis*	*Azadirachta indica* A. Juss.
		Morus alba Linn.
		Celtis australis Linn.
		Ficus religiosa Linn.
		Rosa moschata Hook.
		Ehretia acuminata R.Br.
		Coriaria nepalensis Wall.
Jungle babbler	*Turdoides striatus*	*Coriaria nepalensis* Wall.
Redbilled leiothrix	*Leiothrix lutea*	*Morus alba* Linn.
Dark-throated thrush	*Turdus ruficollis*	*Morus alba* Linn.
		Ficus religiosa Linn.
Oriental white-eye	*Zosterops palpebrosus*	*Coriaria nepalensis* Wall.
Common rosefinch	*Carpodacus erythrinus*	*Morus alba* Linn.

* Three species of parakeets are seed eaters

unviable the seeds of *Celtis australis* Linn. The third species *Psittacula himalayana,* a winter migrant was recorded to be a seed eater of *Pyrus pashia* (Buch.-Ham. ex D. Don.). The remaining 18 avian frugivores contributed to seed dispersal. The true role of these birds in plant propagation could not be assessed, as the viability of seeds passed out by the birds was not tested.

Maximum bird density was recorded on mulberry trees *Morus alba* Linn. which were visited by 9 bird species in April (Table 4). The red colour of the ripening fruits is probably the reason for high density and diversity of birds, as fruit colour is one of the factors determining fruit choice by birds (Wheelwright and Janson 1985). Mulberry fruit, which constitutes an important food item for birds in the study area, ripens at the same time as the breeding season of birds.

Fruit of khirak *Celtis australis* Linn. starts maturing in August-September. During the early period of ripening, it is eaten by parakeets and barbets. But it is during the winter (December-January) when insect food is reduced, that these trees are visited by 10 species of avian frugivores (Table 4). Maximum species diversity was exhibited on these trees during the winter months. *Celtis australis* Linn. is thus an important fruit crop that sustains 10 species of avian frugivores for nearly half the year. All but the two species of parakeets bring about seed dispersal of this species.

Another forestry species in the study area which is predominantly dispersed through an avian frugivore, the black bulbul *Hypsipetes madagascariensis,* is *Azadirachta indica* A. Juss. Black bulbuls feed almost exclusively on the ripe fruits of *Azadirachta indica* A. Juss. during December-February.

Amongst the shrubs, *Coriaria nepalensis* Wall. was the most preferred. Nine species of avian frugivores were recorded visiting it for fruit during April-May (Table 4). The seeds of this shrub species are, therefore, dispersed mainly by birds.

The results of our study show that the relative abundance of Himalayan bulbul and black bulbul was very high, both as a nectarivore and as a seed dispersal agent (Table 4). Relative abundance of Himalayan bulbul was highest as a nectarivore in respect of *Bombax ceiba* Linn. and as a frugivore in respect of *Morus alba* Linn. The Himalayan bulbul was the second most abundant on *Celtis australis* Linn. and also on *Coriaria nepalensis* Wall. (Table 4). Similarly, the black bulbul was the second most abundant species as a nectarivore of *Bombax ceiba* Linn. and as a frugivore of *Morus alba* Linn. Redvented bulbul was an agent of pollination as well as seed dispersal, but its abundance was poor. Overall, the 3 species of bulbuls were agents of pollination of 6 tree/shrub species and seed dispersal of 11 tree/shrub species. Common myna *Acridotheres tristis,* though it was the most abundant frugivore on *Celtis australis* Linn. and also on *Coriaria nepalensis* Wall., was not recorded on *Morus alba* Linn. and its abundance was poor as a nectarivore. The abundance of other members of the family Sturnidae was also poor, both as nectarivore as well as frugivore. The members of the family Pycnonotidae are, therefore, important agents in cross pollination and also in seed dispersal.

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STUDIES ON THE DEVELOPMENT OF THE LABIAL TEETH ROW STRUCTURE IN *RANA CURTIPES* JERDON TADPOLES[1]

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(*With one plate*)

Key words: *Rana curtipes*, development, metamorphosis, labial teeth, tadpoles

The development of the labial teeth row structure of anuran tadpoles of the temperate regions has been studied. However, similar studies on tropical species are scant. The present study is an attempt to describe the ontogeny of the labial teeth row structure of *Rana curtipes*, an endemic species of the Western Ghats of India. *R. curtipes* tadpole has the highest reported number of labial teeth rows, with marginal teeth, among tropical frogs.

INTRODUCTION

The teeth of frogs function primarily to grasp prey, or to position it for swallowing. Their distribution is known to be variable even among closely related groups (Altig 1970). The oral armature of the larvae differs from that of the adults, as they differ in feeding habits.

The ontogeny of the labial teeth row structure of anuran tadpoles inhabiting temperate regions has been studied by several workers (Taylor 1942, Zweifel 1964, Altig 1970, Lee 1976, Webb and Korky 1977, Hero 1990 and Davies 1992). However, our knowledge of the Indian amphibians is scant. Rao (1914), Lobo (1961), Chari (1962), Daniel (1975), Inger *et al.* (1984) and Sekar (1990a) have given brief notes on the mouth parts of Indian amphibians. Agarwal and Niazi (1980), and Dutta and Mohanty-Hejmadi (1983) have reported the ontogeny of the teeth row structure in *Rana tigerina* (now *Hoplobatrachus tigerinus*). The present paper describes changes in the teeth row structure of *Rana curtipes* tadpoles during metamorphosis.

MATERIAL AND METHODS

Fertilized eggs collected from natural habitat were used for the study. Freshly collected eggs were divided into groups of 50 and transferred to a large aquarium (maintained at a photoperiod of 12L:12D at 29 ±2 °C) containing fresh pond water. After hatching, the tadpoles were divided into groups of 10 to avoid overcrowding, and reared in an aquarium of the same size (Group A). Water was changed every second day, and the tadpoles were fed *ad libitum* with boiled spinach. The developing eggs and embryos were observed under binocular microscope to note morphological changes at one hour intervals. Embryos and larvae were staged according to Gosner (1960) system for *Rana pipiens*. Tadpoles of earlier stages were preserved in 5% and later in 10% formaldehyde. Morphological features of the oral armature were studied, and the teeth row formula was determined as per Altig (1970) modified by Webb and Korky (1977), to introduce the "marginal teeth". Tadpole stages from feeding stage onwards were collected from a natural habitat near Thekkady (76° 50 'E, 9° 45 'N), Kerala (Group B). Twenty to thirty tadpoles were examined at each developmental stage.

RESULTS

The number of teeth rows changed with growth. The tadpoles collected from swift waters (stream) had more teeth rows than those reared in the aquarium. A list of teeth row formulae of tadpoles reared in the aquarium at 29 ±2 °C, and those collected from a stream, have been presented in Tables 1 and 2.

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TABLE 1
LABIAL TEETH ROW FORMULA OF *RANA CURTIPES* TADPOLES

Stages	Group A Reared in aquarium		Group B Collected from natural habitat (stream)
	Formula	Percent	Formula
External gill stage	Without teeth	–	Not collected
One external gill covered stage	1/0/2(1)	53	Not collected
	1/0/3(1)	47	
Operculum complete stage	1/0/2(1)	20	Not collected
	2(2)/0/2(1)	53	
	2(2)/0/3(1)	27	
Feeding stage	3(3)/0/3(1)	59	3(3)/0/3(1)
	3(3)/0/4(1)	41	3(3)/0/4(1)
Prelimb stage	4(3-4)/0/4(1)	20	4(3-4)/0/4(1)
	5(3-5)/0/4(1)	46	5(3-5)/0/4(1)
	5(3-5)/0/5(1)	26	5(3-5)/1/5(1)
	5(3-5)/0/6(1)	8	6(3-6)/1/6(1)
Limb bud stage	5(3-5)/1/5(1)	14	6(3-6)/1/6(1)
	6(3-6)/0/6(1)	30	7(3-7)/2/6(1)
	6(3-6)/1/6(1)	36	8(3-8)/3/7(1)
	7(3-7)/1/6(1)	20	8(3-8)/4/8(1)
			9(3-9)/4/7(1)
			9(3-9)/4/8(1)
Foot paddle stage	7(3-7)/2/6(1)	27	8(3-8)/3/7(1)
	7(3-7)/2/7(1)	34	8(3-8)/4/8(1)
	8(3-8)/3/6(1)	39	9(3-9)/5/7(1)
			9(3-9)/5/8(1)
			10(3-10)/5/8(1)
Foot stage	7(3-7)/2/7(1)	22	8(3-8)/2/8(1)
	8(3-8)/0/7(1)	56	9(3-9)/2/7(1)
	8(3-8)/2/6(1)	22	9(3-9)/3/8(1)
			9(3-9)/4/8(1)
			10(3-10)/3/8(1)
Well developed hindlimb stage	7(2-7)/0/7(1)	36	8(3-8)/0/7(1)
	8(3-8)/0/6(1)	31	9(2-9)/0/8(1)
	8(2-8)/0/6(1)	33	9(3-9)/0/8(1)
			10(2-10)/1/8(1)
			10(3-10)/1/8(1)
One forelimb stage	7(1-7)/0/4(1)	61	9(3-9)/0/6(1)
	8(2-8)/0/6(1)	39	8(2-8)/0/7(1)
			7(1-7)/0/6(1)
Both limb and tail stage	5(1-5)/0/3(1-3)	8	5(1-5)/0/3(1-3)
	4(1-4)/0/3(1-3)	32	4(1-4)/0/2(1-2)
	4(1-4)/0/2(1-2)	33	3(1-3)/0/3(1-3)
	3(1-3)/0/2(1-2)	27	
Froglet stage	Without labial teeth		Without labial teeth

Hatching and external gill stage: The stomodaeum, at the anterio-ventral region, was a deep oval pit at the time of hatching. At the external gill stage, it consisted of a pair of oval, black, non-serrated beaks without labial teeth and papillae. However, small indistinct ridges could be seen on the lateral and ventral margins, foreshadowing the labial teeth and papillae.

One external gill covered stage: Tadpoles reached one gill covered stage with widened mouth, and a single row of papillae on the sides of the upper and lower jaws. The edges of the lower jaw had a single row of papillae, the anterior edge of the upper jaw lacked papillae. The beaks became weakly serrated. At this stage, 53% of the tadpoles reared in the aquarium at 29 ±2 °C, had a teeth row formula of 1/0/2(1) and 47% had 1/0/3(1); with a combined formula of 1/0/2-3(1) (Table 2). There was only one uninterrupted row in the upper jaw. The number varied from 2 to 3 in the lower jaw, the first being interrupted by a medial gap. Marginal teeth were absent.

Operculum complete stage: At this stage, 20% of the tadpoles examined had 1/0/2(1) (Table 1), 53% had 2(2)/0/2(1), and 27% had 2(2)/0/3(1) formulae. The first row in the upper, and the second and third in the lower jaw, when present, were uninterrupted. However, the first row in the lower, and the second in the upper jaw, were centrally broken. In the majority of tadpoles, teeth in the two jaws were weakly developed. The combined teeth row formula was 1-2(2)/0/2-3(1).

Feeding stage: A single row of labial papillae appeared around the lateral and posterior margin of the anterio-ventral mouth. The second continuous row of teeth in the upper jaw appeared for the first time. The third and fourth rows of ventral jaw were poorly developed; marginal teeth were not present at this stage. The teeth row formula varied from 3(3)/0/3(1) to 3(3)/0/4(1), in two groups of tadpoles, and thus the combined formula 3(3)/0/3-4(1) was the same for both groups.

James, Jinesh *et al.*: *Rana curtipes* PLATE 1

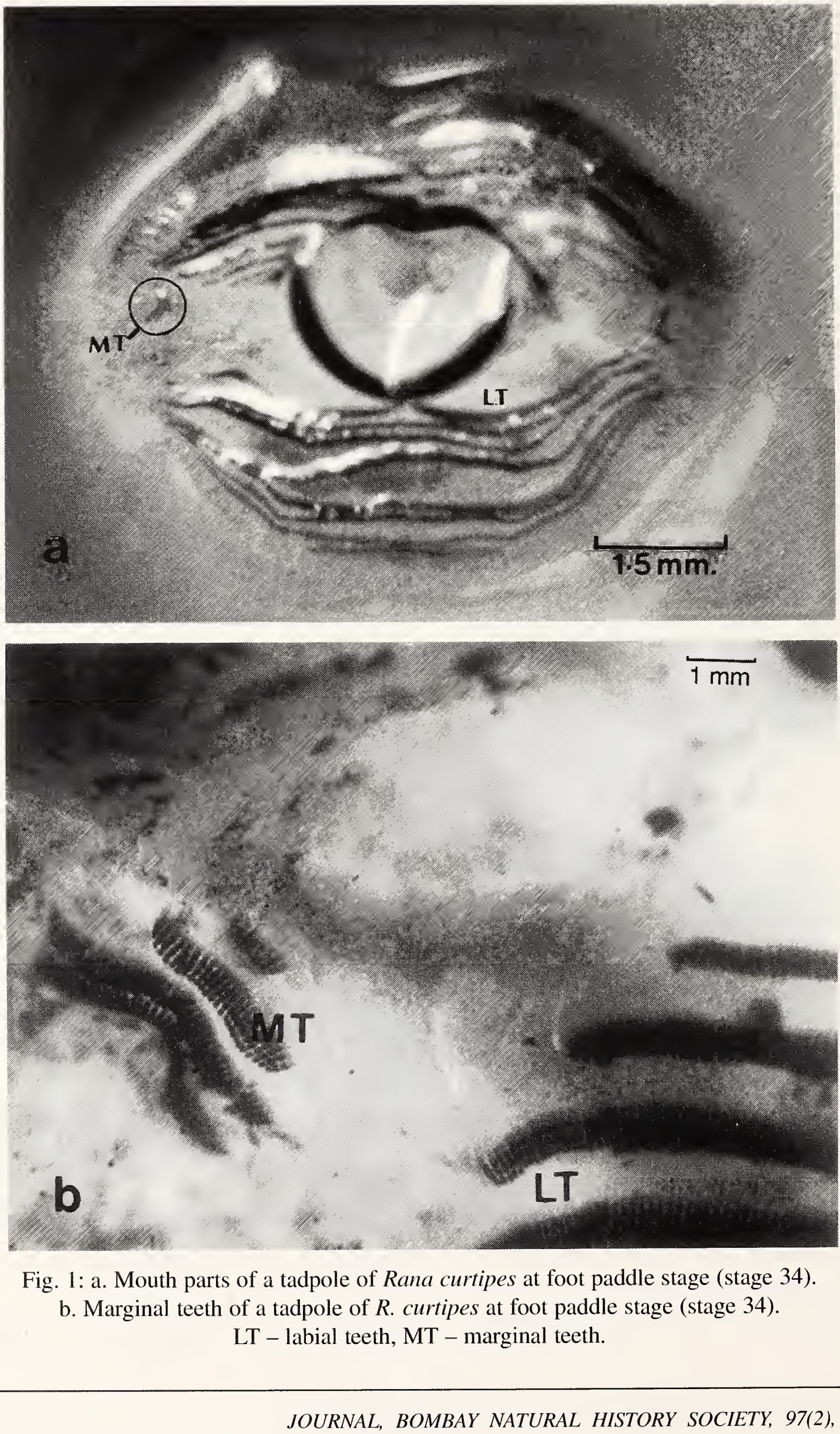

Fig. 1: a. Mouth parts of a tadpole of *Rana curtipes* at foot paddle stage (stage 34).
b. Marginal teeth of a tadpole of *R. curtipes* at foot paddle stage (stage 34).
LT – labial teeth, MT – marginal teeth.

Table 2
COMBINED LABIAL TEETH ROW FORMULA OF *RANA CURTIPES* TADPOLES

Stages	Group A Reared in aquarium	Group B Collected from natural habitat (stream)	General combined formula
External gill stage	Without teeth	Not collected	Nil
One external gill covered stage	1/0/2-3(1)	Not collected	1/0/2-3(1)
Operculum complete stage	1-2(2)/0/2-3(1)	Not collected	1-2(2)/0/2-3(1)
Feeding stage	3(3)/0/3-4(1)	3(3)/0/3-4(1)	3(3)/0/3-4(1)
Prelimb stage	4-5(3-5)/0/4-6(1)	4-6(3-6)/0-1/4-6(1)	4-6(3-6)/0-1/4-6(1)
Limb bud stage	5-7(3-7)/0-1/5-6(1)	6-9(3-9)/1-4/6-8(1)	5-9(3-9)/0-4/5-8(1)
Foot paddle stage	7-8(3-8)/2-3/6-7(1)	8-10(3-10)/3-5/7-8(1)	7-10(3-10)/2-5/6-8(1)
Foot stage	7-8(3-8)/0-2/6-7(1)	8-10(3-10)/2-4/7-8(1)	7-10(3-10)/0-4/6-8(1)
Well developed hindlimb stage	7-8(2-8)/0/6-7(1)	8-10(2-10)/0-1/7-8(1)	7-10(2-10)/0-1/6-8(1)
One forelimb stage	7-8(1-8)/0/4-6(1)	7-9(1-9)/0/6-7(1)	7-9(1-9)/0/4-7(1)
Both limb and tail stage	3-5(1-5)/0/2-3(1-3)	3-5(1-5)/0/2-3(1-3)	3-5(1-5)/0/2-3(1-3)
Froglet stage	Nil	Nil	Nil

Prelimb stage: The teeth row formulae of the tadpoles reared at 29 ±2 °C were 20% 4(3-4)/0/4(1), 46% 5(3-5)/0/4(1), 26% 5(3-5)/0/5(1) and 8% 5(3-5)/0/6(1). The last row of the lower jaw in 70% of the tadpoles was poorly developed. The combined formula 4-5(3-5)/0/4-6(1) indicated that, of 4 to 5 rows in the upper jaw, the first two rows were uninterrupted, marginal teeth were absent and in the lower jaw the teeth rows varied from 4 to 6, with the first row uninterrupted. Two rows of submarginal papillae could be seen on the sides of the upper and lower jaws.

The combined teeth row formula, 4-5 (3-5)/0/4-6(1), of tadpoles reared in the lab indicates the presence of a maximum of five rows in the upper jaw and six rows in the lower jaw. The combined teeth row formula of tadpoles collected from the stream was 4-6(3-6)/0-1/4-6(1). One row of marginal teeth was observed for the first time in 40% of the tadpoles.

Limb bud stage: In this stage of development, Group A had 14% 5(3-5)/1/5(1), 30% 6(3-6)/0/6(1), 36% 6(3-6)/1/6(1) and 20% 7(3-7)/1/6(1) labial teeth row formulae. Group B tadpoles varied widely in the number of teeth rows at this stage (Table 1). One row of marginal teeth appeared for the first time in tadpoles reared in the aquarium. Another characteristic was the development of two to three rows of sub-marginal papillae on the sides of both jaws. The lower and upper beaks were strong, serrated and keratinized. As in some of the previous stages, the last row of labial teeth in the lower jaw was poorly developed, or incomplete. The combined teeth row formula was 5-7 (3-7)/0-1/5-6(1) in Group A and 6-9(3-9)/1-4/6-8(1) in Group B.

Foot paddle stage: The combined teeth row formulae of Group A [7-8 (3-8)/2-3/6-7(1)] and Group B [8-10(3-10)/3-5/7-8(1)] indicated that maximum upper labial, lower labial and marginal teeth appeared for the first time in this stage. Maximum upper labial teeth rows in Group A were 8 and in Group B 10. Similarly, the maximum marginal teeth rows observed in Group A were 3. In Group B, the minimum and maximum marginal teeth rows were 3 and 5 respectively (Plate 1). All the rows of teeth in

the upper and the lower jaws were well developed.

Foot stage: In Group A tadpoles, 22% had 7(3-7)/2/7(1), 56% had 8(3-8)/0/7(1) and the remaining 22% had 8(3-8)/2/6(1) formulae. Thus, 78% of tadpoles of Group A at this stage had 8 rows in the upper jaw. Another feature at this stage was the reduction in marginal teeth. 56% in Group A had completely lost their marginal teeth. Likewise, in Group B, the majority had less than 4 rows of marginal teeth.

A comparison between foot paddle and foot stages indicates that while there was an increase in the percentage of labial teeth row number in foot stage, a decrease in marginal teeth row number also occurred in both groups of tadpoles at the foot stage.

Well developed hindlimb stage: All the tadpoles of Group A and a number of tadpoles in Group B had lost their marginal teeth. Second labial teeth row became broken in 69% of tadpoles. Thus, reduction or shedding of labial teeth had started at this stage. None of the tadpoles had the full complement of teeth at this stage.

One forelimb stage: Teeth row formula varied from 7(1-7)/0/4(1) to 8(2-8)/0/6(1) in Group A tadpoles. The combined formula of Group B was 7-9(1-9)/0/6-7(1). In the majority of tadpoles, both upper and lower jaw had intermittently broken labial teeth rows. The shedding of labial teeth had already started prior to this stage. The rows of sub-marginal papillae were absorbed, and limited to the corners of the mouth. The number of papillae decreased in the lower jaw. The horny beaks, both upper and lower, became thick, colourless or white, except at the edges where they were black at this stage.

Both limb and tail stage: In both groups of tadpoles, the combined teeth row formula was the same, 3-5(1-5)/0/2-3(1-3). All the rows in the upper and lower jaws were interrupted with lost teeth, and limited to the corners of the mouth. The labial fringes, which were present on the lateral sides of mouth in the previous stages, were absorbed and papillae were seen in small clusters at the corners of the mouth. The horny beaks disappeared. The mouth widened, and the corners reached the level of the posterior margin of the eyes.

Discussion

The present study shows that there are variations in the development of labial teeth row structure in tropical anurans. The number of teeth rows changes with the stage of development, and for each stage there are individual variations. Table 1 indicates that labial teeth appear at the one external gill covered stage, and reach a full complement of rows at the foot paddle stage. Labial teeth rows maintain this full complement up to the well-developed hindlimb stage. Before the onset of metamorphosis, labial teeth begin to shed and disappear with the completion of metamorphosis. Dutta and Mohanty-Hejmadi (1983) reported a similar pattern in *Rana tigerina* (now *Hoplobatrachus tigerinus*). Further, the present study shows that the teeth rows in the upper jaw vary from 1 to 10. Similarly, the labial teeth rows in the lower jaw vary from 2 to 8. The combined teeth row formula for *Rana curtipes* according to Rao (1914) is 6-8(4-8)/6-8(1), and Sekar (1990b) is 7(3-7)/5-8(1) or 7(4-7)/5-8(1). The present observation agrees with the views of Rao (1914) and Sekar (1990b) in the maximum number of rows and nature of the first row in the lower jaw.

The present study established that *Rana curtipes* tadpoles have marginal teeth, which make their first appearance in the prelimb stage (Table 2), reach a maximum at the foot paddle stage, and begin to disappear at the foot stage. The number of marginal teeth varies from 0 to 5 in *Rana curtipes*. Similar findings have been reported in *R. pustulosa* (Taylor 1942), *R. tarahumarae* (Zweifel 1955) and *R. macroglossa* (Volpe and Harvey 1958). But none have reported

the presence of marginal teeth in a tropical anuran.

Some differences were also found in the number of teeth rows between aquarium reared tadpoles, and those collected from their natural stream habitat. The tadpoles developed in the aquarium differ significantly from those collected from streams in the number, pattern and percentage of occurrence of labial and marginal teeth rows. In *Rana curtipes*, 10 rows of labial teeth in the upper and 8 rows in lower jaw indicate that the species has the largest number of labial teeth rows among tropical frogs. Labial teeth row formulae reported by Inger *et al.* (1984) for *R. temporalis* [2(2)/0/2(1)], *R. beddomi* (now *Indirana beddomii*) [4(4)/0/4(1-2)] and *R. keralensis* (now *Limnonectes keralensis*) [2(2)/0/3], by Chari (1962) for *R. malabarica* [1/0/2(1)] and by Sekar (1990b) for *Rhacophorus malabaricus* [6(3-6)/0/3(1)], were less than those of *Rana curtipes*. The maximum number reported for *R.tigerina* (now *Hoplobatrachus tigerinus*), by Dutta and Mohanty-Hejmadi (1983), was 5(2-5)/0/(1-3).

The above observations reveal that *Rana curtipes* has the largest number of labial teeth rows among tropical anurans and the number of teeth rows changes with the development of tadpoles.

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BURROW PATTERN OF INDIAN METAD *MILLARDIA* (*RATTUS*) *MELTADA* GRAY[1]

N.K. Pandey and A.S. Bhadauria[2]

(*With one text-figure*)

Key words: Burrow pattern, *Millardia meltada*, brood chamber, emergency openings, hoarding behaviour, bolt run

Burrow pattern in *Millardia* (*Rattus*) *meltada* Gray was studied by excavating ten burrows every alternate month in 1992. Measurements of the burrows were recorded and found to be as follows: average length 106.2 cm, breadth 45.8 cm, depth 38.1 cm and diameter of burrow openings 3.6 cm. The average number of brood chambers (1.13), food chambers (1.13), surface openings (2.73), emergency openings (0.78), and rats (3.17), per burrow, were also noted. Hoarding behaviour was studied by collecting food materials, the average being 50.12 gm per burrow. *M. meltada* was found to have a very simple burrow structure with no boltruns. A hole covered with a thin layer of soil at the distal end was used during emergency. The burrows had one to four openings at the surface, with a heap of excavated soil near one of the openings. The burrows were deeper in summer than in winter.

Introduction

Rats are unwelcome associates of mankind from time immemorial. They cause enormous losses to agricultural crops at every stage, from production to consumption. According to one estimate, rats inflict damage of 6 to 10% on standing crops and 5 to 15% in storage (Jain and Tripathi, 1988). Besides feeding voraciously, they contaminate the food material with their droppings, urine and hair. Rats are carriers of many diseases that afflict humans and domestic animals.

Most of the rat species construct burrows and thus threaten conservation work. The Indian desert gerbil, *Meriones hurrianae* (Jerdon) unearths about 17,000 kg soil per hectare, which is blown away by strong wind, increasing the area of sandy waste and barren land (Prakash, 1976). Little information is available on the burrow pattern in different rat species, which is of importance in rodent pest management. Hence, the present study was undertaken.

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Study Area

The burrow pattern of Indian metad, *Millardia (Rattus) meltada* was studied by digging burrows on five agricultural research farms viz. Students Research Farm, Research Farm, Oilseed Research Farm, New Dairy Farm and Vegetable Research Farm of this University and five villages viz. Gangpur, Gambhirpur, Prempur, Singhpur and Bairy-Akbarpur located in the development block Kalyanpur, Kanpur Nagar (U.P.). Most of the study area was under various cropping system. The main crops grown were cereals, pulses, oilseeds and vegetables.

Material and Methods

The test species was identified at the Zoological Survey of India, Calcutta. Burrows of *Millardia meltada* were unearthed in 1992 and ten burrows studied in alternate months. The morphometrics of the burrows, i.e. their openings, length, breadth, depth and number of internal structures, like brood chambers, storage/ food chambers, boltruns, escape holes (emergency openings), number of animals and quantity of hoarded material were recorded. The

burrows generally had 1-4 openings on the burrow surface. Live burrows were identified by closing them in the evening and examining them the next day. Open burrows with freshly excavated soil were considered live. Atmospheric temperature, relative humidity and rainfall were recorded to correlate the burrowing pattern with the meteorological conditions.

Results and Discussion

The structure of a *M. meltada* burrow is depicted in Fig. 1 and its measurements are presented in Table 1. The average length, breadth, depth and diameter of burrow openings were 106.2 cm, 45.8 cm, 38.1 cm and 3.6 cm respectively. The average number of brood chambers (1.13), food chambers (1.13), surface openings (2.73), emergency openings (0.78) and metads (3.17) were noted. The hoarded food material (average 50.12 gm per burrow) was generally present in the channels of the burrows; specialised food chambers were also noted in some cases. No boltruns were recorded in any burrow.

M. meltada made very simple burrows with a depth of 32.7 to 47.5 cm. The length and breadth ranged from 89.1 to 124.9 cm and 32.9 to 68.3 cm, respectively. The burrows had one to four clear openings and a heap of soil near one of them. Females lived with young ones in a burrow during parturition. The litters formed separate burrows when they could move and feed freely. Solitary females were found with an average of 2.7 young ones in a burrow. Females were observed placing smooth grasses in the brood chambers.

There were no boltruns in the burrow channels. Interestingly, in some cases the long, upwardly directed branches of the burrow channels ended in a very thin layer of soil at the surface. The metads were observed running out suddenly from these burrows by removing the thin soil layer in one stroke. These structures formed emergency openings or escape holes. Escape holes were observed in some burrows with an average of 0.78 escape holes per burrow.

The burrows were deeper during the summer, the mean depth being 40.6 cm in April and 47.5 cm in June and comparatively shallow during the winter (33.8 cm and 32.7 cm in

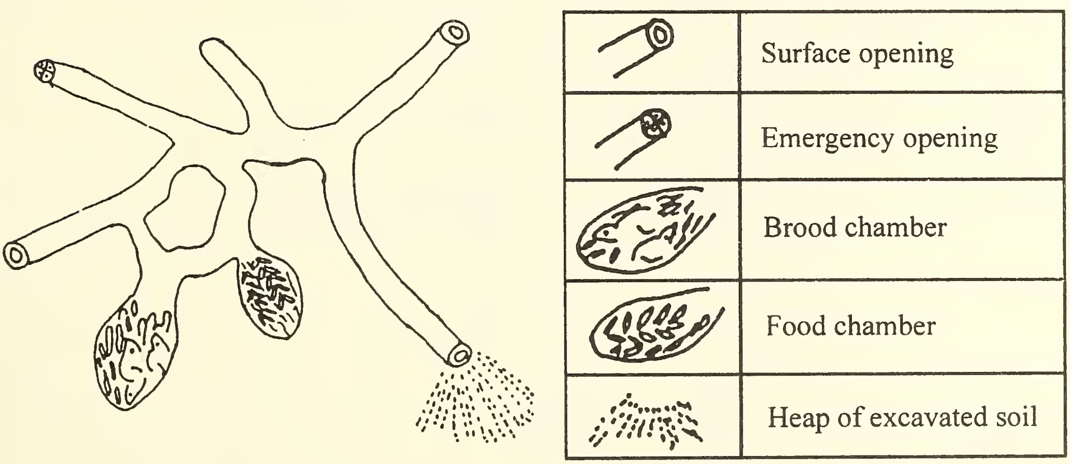

Fig. 1: Burrow pattern of *Millardia* (*Rattus*) *meltada* Gray

TABLE 1

BURROW STRUCTURE OF THE INDIAN METAD, *MILLARDIA (RATTUS) MELTADA* GRAY

Months	External appearance of burrow	No. of burrows dug	Mean length of burrow (cm)	Mean breadth of burrow (cm)	Mean depth of burrow (cm)	Mean diameter burrow openings (cm)	Mean No. of brood chambers	Mean No. of food chambers	Mean No. of surface opening	Mean No. of rat\burrow	Mean No. of boltrun/ burrow	Mean No. of escape holes	Mean quantity of hoarded materials (gm)
February	Clearly opened burows	10	113.6	54.4	34.0	3.60	1.3	1.1	2.8	2.8	Nil	0.6	53.0
April	"	10	121.0	32.9	40.6	3.70	1.4	1.2	2.9	4.3	Nil	0.9	58.9
June	"	10	124.9	34.6	47.5	3.58	1.1	1.2	2.6	2.5	Nil	0.7	47.6
August	"	10	89.1	54.6	39.9	3.50	0.8	1.0	2.5	2.4	Nil	0.8	33.5
October	"	10	90.6	68.3	33.8	3.35	1.0	1.1	2.8	2.1	Nil	0.7	60.2
December	"	10	118.9	61.8	32.7	3.43	1.2	1.2	2.8	4.9	Nil	1.0	47.5
Average			106.2	45.8	38.1	3.6	1.13	1.13	2.73	3.17	—	0.78	50.12
S.D.			15.79	14.40	5.69	0.12	0.21	0.08	0.15	0.14	—	0.17	9.7
S.E. ±			6.44	5.87	2.32	0.05	0.08	0.03	0.06	0.46	—	0.06	3.9

October and December, respectively). The mean atmospheric temperature during 1992 was 33.98 °C in June and 16.34 °C in December.

The length of the burrow was maximum during the summer (mean 124.9 cm in June) and minimum in the monsoon (mean 89.1 cm in August). During the winter, the burrow length was high (mean 118.9 cm in December). The breadth was highest in October (mean 68.3 cm) and lowest in April (mean 32.9 cm).

The length, breadth, depth and surface openings found in this study are in accordance with those reported by Chopra and Sood (1980), but they have reported the presence of boltruns and absence of brood chambers, contrary to our observations.

In *R. meltada pallidior*, Rana and Prakash (1980) reported 3-6 surface openings and 3-5 boltruns per burrow system, while in the present study, the mean number of surface openings were 2.73 with no boltruns.

Similar morphometric studies of *Bandicota bengalensis* burrows were done by Sagar and Bindra (1968), and Sood and Gill (1978). Likewise, Prakash (1981) made burrow measurements of *Meriones hurrianae*, *Tatera indica* and *Gerbillus gleadowi* in Rajasthan. Bhadauria (1992) studied burrow patterns of *Bandicota bengalensis* and *Tatera indica* and reported measurements of similar surface openings, bolt runs etc., which are in accordance with our data.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF THE BOMBAY NATURAL HISTORY SOCIETY — 38. PASSERINAE[1]

Saraswathy Unnithan[2]

(Continued from Vol. 93 (2), 251)

This part deals with 453 specimens of 21 species, subspecies and 5 ELs, up to no. 1956 in the INDIAN HANDBOOK (10:87) and no. 24263 of the Society's register. We do not have specimens of 5 subspecies out of the 21 species and subspecies.

1938 ***Passer domesticus indicus* Jardine & Selby**. (India, restricted to Bangalore by Kinnear, 1925, *Ibis*: 751) Indian house sparrow. 3:170-72

85 : 57 males, 26 females, 2 unsexed.

1 Dehak, Nashkhil, 1 Bampur, Per Baluchistan, 2 Gajar, Kalat, 1 Mastung, Baluchistan, 1 Lahore, 2 Rawalpindi, 1 Jagadri, 2 Ambala, 1 Latura, 2 Campbellpur, Punjab, 2 Yoginath, Garhwal, 1 Ramgarh, Naini Tal, 1 Shogi, Patiala State, 1 Gama Ki Hatti, Dharmi State, 13 Simla, 2 Lalsohara, Bahawalpur, 1 Bahawalpur Town Environ, 1 Manthar, Cholistan, 5 Delhi, 1 Meerut, 8 Bharatpur, 1 Chaduva, Bhuj, 1 Changalra, Bhuj, 1 Kuarbet, Banni, Kutch, 3 Karirohar, Kutch, 1 Nadiad, Gujarat, 1 Gir Forest, 2 Nasardi, Nasik. 1 Colaba, 5 Bombay, 1 Worli, 1 Andheri, 3 Marole, Salsette, 1 Murgimatta, 2 Sagar, Shimoga, Mysore, I Maraiyur, Travancore, 1 Cape Comorin, 1 Koira, Bonai, Orissa, 1 Satanwara, Gwalior, 1 Kanpur, 1 Purulia, Manbhome, 1 Baghownie, Darbhanga, 2 Dibrugarh, Assam, 1 Bijapur, Nepal, 1 Hambentota, Sri Lanka.

Some of the northern birds are large (wing 78-79 mm) but the males lack the rich rufous of *parkini* and are left with *indicus,* leaving a slight overlap in the size range between this and *parkini.* They include an albino from Bombay city which could have been brought to Bombay in captivity and released.

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Measurements on p. 237.

1938a ***Passer domesticus confucius* (Bonaparte)** (China, *errore*; =Rangoon) 3: 172

12 : 9 males, 3 females.

5 Shwebo, U. Burma, 5 Port Blair, Andaman, 1 Sipighat, 1 Choldhari, S. Andaman.

The females are barely separable from *indicus* from peninsular and eastern India, but the colours of the males resemble *parkini* from Kashmir, though both sexes are much smaller. The race was accepted in Stuart Baker's FAUNA, but discarded by Ticehurst in his comments (*JBNHS 32*: 346) as it was said to be based on a single specimen, and again by Biswas (RECORDS OF INDIAN MUSEUM 45: 225), on the strength of a male and female in the Indian Museum. No one else appears to have looked into this matter, but the specimens listed above are distinct, and those from the Andaman and Nicobar Islands are presumably from Burma (*JBNHS 61*: 569).

Measurements on p. 237.

1939 ***Passer domesticus parkini* Whistler**. (Srinagar, Cashmere). Kashmir house sparrow 3: 173.

7: 4 males, 3 females.

1 Kashmir Valley, 1 Chashmashahi, Srinagar, 4 Leh environs, Ladakh, 1 Tshomarari Lake.

Larger and darker than *indicus,* females are difficult to distinguish from *bactrianus*.

Measurements on p. 237.

1939a ***Passer domesticus bactrianus* Zarudny & Kudashev** (Tashkent). Turkestan house sparrow.

27: 10 males, 16 females, 1 unsexed.

6 U.S.S.R. 8 Chitral, 1 Manthar, Cholistan, Bahawalpur, 1 Bhinmal, Jodhpur, 11 Bharatpur, Rajasthan.

Winter visitor. Birds ringed in Bharatpur in 1962 (3), 1963 (1), and 1969 (1) were caught in Kazakhistan (2) and Tadjikstan (3) and named

bactrianus by E.I. Gavrilov, Dement'ev and Gladkov, in the BIRDS OF THE SOVIET UNION Vol. V. P. 403 (1970). They have synonymised *bactrianus* with *griseogularis* Sharpe, (Kandahar) the Central Asian house sparrow.

Measurements on p. 237.

EL ***Passer domesticus domesticus* Linnaeus** Sweden. Common house sparrow.

1 male from *Szeged Hungary.*

Measurements on p. 237.

EL ***Passer domesticus biblicus* Hart.** Palestine. Near Asian house sparrow.

17: 13 males, 4 females.

1 Residency, 1 Kazimaim, 2 Baghdad, 1 Shiraz, 1 Amara, 1 Kasviw, 1 Sheik Saad, 1 Bait-al-khalifa, 4 Haviplain, Samara; 4 Shat-el-Adhaim, Mesopotamia.

Palest of all subspecies of *domesticus.*

Measurements on p. 237.

1940 ***Passer hispaniolensis transcaspicus* Tschusi** (Transcaucasia = Iolotan, Transcaspia). Spanish sparrow.

57: 37 males, 20 females.

1 Yarkand, 1 Cairo market, Egypt, 2 Feluja, R. Euphrates, 3 Zorr R. Tigris, 2 Mesopotamia, 2 Shustar, S. Persia, 2 Shush, Kain, Persia, 1 Amara, 1 Sheikh Saad, 2 Mishun, Persian Gulf, 1 Tang, Mishun, 1 Sulebadar, P. Gulf, 2 Seh Kaleh, Tun, P. Gulf, 12 Chitral, 1 Lalsohara, 1 Bahawalpur tn. env., 2 Jagadri, 2 Ambala, 2 Thanesar, Karnal dist., Punjab, 3 Ganjus Canal, Meerut, 13 Bharatpur, Rajasthan.

Females very similar to those of *domesticus*, but with faint streaks on the breast, and heavier bills.

Measurements on p. 237.

1941 ***Passer montanus dilutus* Richmond** (Kashgar, Eastern Turkestan). Afghan tree sparrow 3-178

32, 16 males, 9 females, 7 unsexed.

2 Kafir Kaleh, Nr Meshed, 3 Ghirk, Nr. Birjand, 2 Birjand, 1 Shwesh, Kain, 1 Sistan. 1 Shush, 1 Bunjar, Sistan Delta, Kain, 4 Nasratabad, Sistan, Kain, 3 Mohemabad, Persia, 1 East Persia; 1 Wana, Waziristan, 4 Chitral, NWFP, 1 Deh - Jotegh, 2 Quetta, 2 Chaman, 1 Zurtta, Baluchistan, *1 Tientsin, 1 Khotan, China.*

It is the palest of all the subspecies of *Passer montanus.*

Measurements on p. 237, 238.

1942 ***Passer montanus malaccensis* Dubois** (Malacca). Malay tree sparrow.

21: 11 males, 10 females

1 Ambrang Village, Nepal; 1 Kurseong, Sikkim; 1 Bumthang, 5 Tama, Central Bhutan, 1 Rongtong, 1 Deothang, 6 Gomchu, East Bhutan; *1 Maymyo, 3 Shwebo, U. Burma, 1 Padaung, Prome dist., C. Burma.*

There are two distinct colour groups, one pale brown from upper Burma, collected in 1908, Maymyo (1913) and Padaung (1929), and a very dark group collected from Bhutan in March 1966 and 1967(9 males and 5 females). A female from Gomchu, E. Bhutan (16.iii.1966) Regn. No. 25614 is with very dark brown or sooty black head and tail and with under parts grey.

Measurements on p. 237, 238.

1943 ***Passer montanus tibetanus* Baker** (Khumbalong, Tibet) Tibetan tree sparrow 3: 179.

nil

1944 ***Passer montanus hepaticus* Ripley** (Tezu, Mishmi Hills, NE. Assam). Mishmi tree sparrow 3: 177

6: 5 males, 1 female

2 Shillong, 1 Margherita, 1 Dibrugarh, 2 Tezu, Lohit Valley, Upper Assam.

Two Tezu specimens, collected in 1948, are darker than the others collected in 1901 and 1908, and also than the *malaccensis* collected in 1908 (Burma), but are definitely paler than the more recently collected *malaccensis* specimens of Bhutan. The key in the HANDBOOK, Vol. 10. p. 69 says that *hepaticus* is the darkest.

Measurements on p. 237, 238.

EL ***Passer montanus montanus* Linn.** Common field (tree) sparrow.

1 Male *Hungary, Europe.*

Measurements on p. 237.

EL ***Passer montanus transcaucasicus* Buturlin** Akhaltsikhe. Transcaucasian field sparrow.

1 male from *Engeli, Persia*

Measurements on p. 238.

1945 ***Passer pyrrhonotus* Blyth** (Buhawalpore, Scinde). Sind jungle sparrow 3: 174.

16: 11 males, 5 females.

6 Lahore, 1 Phillaur, Jullunder dist., 1 Ferozepore, 1 Multan, 1 Mahmud Kot, Multan dist., 2 Bahawalpur tn. env. 2 Sukkur, Sind, 2 no locality.

These specimens were collected from 1893 to 1940. 5 males (1 Lahore, 1 Multan, 1 Mahmud Kot, 2 no locality) have very light grey or almost white under parts, the rest with ashy grey under parts. Season or age of the specimen could not be correlated with this change in the colouration.

Measurements on p. 238.

1946 ***Passer rutilans cinnamomeus* (Gould)** N.W. Himalayas. Himalayan cinnamon tree sparrow. 3:181

West Himalayan Birds

53: 34 males, 13 females, 6 unsexed.

2 Chitral Drosh, 2 Chitral Nagar, 3 Chitral, 3 Liddar Valley, 1 Yusmarg, 4 Kashmir, 2 Dalhousie, 1 Chandigarh, Ambala dist., Punjab, 1 Keonthal St., 1 Patiala St., 1 Fagu, Simla Hills, 1 Nichar, 13 Simla, 1 Kalka, N.W.H.; 3 Lambathatch, 2 Mornaula, 1 Kedarnath, 1 Guptakashi, 1 Chamoli, 2 Garhwal, 1 Lohaghat, 2 Almora, 4 Mukteswar, Nainital.

Bhutan Birds

14: 9 males, 5 females

1 Gedu, W. Bhutan, 4 Bumthang, 2 Gyetsa, 1 Shamgong, C. Bhutan, 3 Rongtong, E. Bhutan, 3 Shillong.

Specimens 7980 and 7981 from Simla and 7993 from Shillong marked as males are in fact in female plumage with the characteristic conspicuous long white supercilium. Bhutan and Shillong specimens are quite different from the Kashmir, Punjab and Garhwal specimens. The former, both males and females, are darker with yellow almost absent in the plumage.

Measurements on p. 238.

1947 ***Passer rutilans intensier* Rothschild** (Mekong Valley). Yunnan cinnamon tree sparrow. 3: 180

One male from *Fortwhite, Chin Hills, U. Burma*.

Measurements on p. 238.

1947a ***Passer moabiticus yatii* Sharpe** (Dedadi, Seistan, Western Afghanistan) Afghan scrub sparrow

EL. ***Passer flaveolus* Blyth** (Pegu). Pegu house sparrow.

7:5 males, 2 females.

3 Shwebo, U. Burma, 1 Ngaphaw, 1 Prome, Prome Dt., 1 Ingabu, 1 Henzada, Henzada Dt., Burma.

Measurements on p. 238.

nil

1948 ***Petronia xanthocollis transfuga* (Hartert)** Bagu, Kelat, Baluchistan. Sind yellowthroated sparrow. 3:168

26: 14 males, 6 females, 6 unsexed.

1 Quarradah, 1 Bagdad, 2 Basra dist., Iraq, 1 Fao, Persian Gulf, 1 Rodkan, Kolwa, 1 Muradkhan, Kalat, Baluchistan, 1 Sardar R. Haripur, NWFP, 2 Darazpur, Ambala dist., 3 Ambala, Punjab, 1 Sairi, Patiala St., North-West Himalaya, 1 Hamavas lake, Pali dist., 1 Phulji, Larkana, Sind, 1 Jalor, Jodhpur, 1 Deesa, Palanpur, 5 Bhuj, Kutch, 1 Radhanpur, 1 Nadiad, 1 Vaghjipur, Mehsana dist.

7 specimens (4 from Kutch, 1 Nadiad, 1 Deesa and 1 Radhanpur) are marked by Dr. Sálim Ali as intergrades between *transfuga* and *xanthocollis*. 6 specimens (5 males and one unsexed) are with black bills (3 of them in February, one in March, another in October and the unsexed without date). Two of the unsexed specimens are juveniles. A male specimen from Muradkhan, Kalat collected on 8.ix.1917 is very

TABLE 1
MEASUREMENTS OF THE BIRDS IN THE COLLECTION OF BNHS

	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
	1938-1939a *Passer domesticus* subspp & ELs			
Male				
1938 *indicus* (57)	70-82 av. 74.8 (IH 70-82	9.5-11.5 av. 10.5 from skull 13-15	19-20 av. 19.4 18-20	50-60 av- 55.5 49-61)
1938a *confucius* (9)	69-77 av. 72.7 (Baker 69-74)	9.5-12 av. 10.3	19-20 av. 19.3	50-57 av. 52.8
1939 *parkini* (4)	80(3), 85 (IH-74-85	10.5, 11 (2), 12 from skull 14-15	19, 20(3) 19-20	55, 56, 60, 62 55-62)
1939a *bactrianus* (10)	73-81 av. 76.5 (IH 75-8 1)	10.5-12 av. 11-3	17.5-19.5 av. 18.6	50-57, av. 55
EL. *biblicus* (13)	76-81 av. 78.6 (Dement'ev 76-79 av. 77.4	10-12.5 av. 11.6 9.5-10 av. 9.9)	19-20 av. 19.6	48-60 av. 55.6
EL. *domesticus* (1)	83 (Dement'ev 73-83	12 9-11 av. 9.9)	20 -	56 -
Female				
1938 *indicus* (26)	66-79 av. 72.1 (IH 70-80	9.5-11.5 av. 10.6 from skull 13-15	19-20 av. 19.1 18-20	45-57 av. 51.7 51-57)
confucius (3)	70 (2), 76 (Baker 65-77)	10, 10.3, 11	19, 20 (2) -	45, 49, 55 -
parkini (3)	75,76(2) 73-16	11.5(3) from skull 13-15	19,19.2, 19.7 19-20	53, 56, 57 52-67)
bactrianus (16)	73-80 av. 75.4 (IH -72-78)	11. 1-12.2 av. 11.4 -	17.6-21 av. 19.06 -	53-58 av. 54.6 -
EL. *biblicus* (4)	71-81 av. 75.8 (Dement'ev 72-78 av. 75.3	11-11.7 av. 11.3 9.3-10 av. 9.2)	19-20 av. 19.4 -	51-60 av. 55.1 -
	1940 *Passer hispaniolensis transcaspicus*			
Males (37)	76-82 av. 79.2 (IH '73-87	11-13 av. 11.9 from skiffl c. 16	19-22 av. 20.4 19-20	53-60 av. 56.2 57-62)
Females (20)	74-80 av. 7 6.9 (IH 73-82	11-12. 5 av. 11.8 from skull c. 16	19-21.5 av. 2 0 19-20	52-59 av. 54.8
	1941-44 *Passer montanus* sub spp. & ELs			
Males				
1941 *dilutus* (16)	71 -76 av. 73.1 (Baker M/F 78-83	9.8-11.3 av. 10.5 -	17.5-20.2 av. 18.6 18-19	51-59 av. 55.8 50-55)
1942 *malaccensis* (11)	65-74 av. 70.6 (IH 67-76	10. 1-11. 5 av. 10. 7 from skull 11-14	17.4-19.5 av. 17.7 15-19	49-56 av. 53.2 52-57)
1944 *hepaticus* (5)	63-70 av. 67.2 (IH 68-71	10-11. 1 av. 10. 58 -	17-18.7 av. 17.9 -	50-53 av. 51.4 50-54)
EL *montanus* (1)	69 (Dement'ev 65-75	10.6 10-12)	20 -	55 -

Table 1 (contd.)
MEASUREMENTS OF THE BIRDS IN THE COLLECTION OF BNHS

	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
EL *transcaucasicus* (1)	64 (Dement'ev 64-70)	10.8	17.5	46
Females				
dilutus (9)	70-74 av. 71.4	9.9-10.6 av. 10.3	17.4-19.5 av. 18.4	50-57 av. 54.2
malaccensis (10)	67-73 av. 69.5 (IH 66-74	9.5-11.2 av. 10.3 from skull 12-13	17-18.5 av. 17.8 15-19	52-55 av. 53.2 50-56)
hepaticus (1)	67	11.1	18	50
1945 *Passer pyrrhonotus*				
Males (11)	64-71 av. 67.7 (IH 67-70	9.1-10.2 av. 9.5 from sk-ull 11-12	16.3-20av. 17.8 16-17	48-54 av. 51 49-55)
Females (5)	63-65 av. 64 (IH 63-65	9.5- 10 av. 9.7 from skull 11-12	16-17 av. 16.7 16-17	44-50 av. 47 48-49)
1946-47 *Passer rutilans* subspp.				
Male				
1946 *cinnamqmeus* (32)	67-75 av. 71.06 (IH 68-82	9.5-11.5 av. 10.7 from skull 12-14	16-18.8 av. 17.4 17-21	45.55 av. 49.5 46-56)
1946 (a) Bhutan (9)	70-80 av. 73.1	10.3-11.8 av. 10.8	16.3-18.2 av. 17.2	45-56 av. 50.5
1947 *intensier* (1)	71 (Baker 69-77	11.1 11-12)	18.5 -	48 -
Females				
cinnamomeus (15)	65-71 av. 68.6 (IH 60-78	10.2-11.3 av. 10.6 from skull 12-14	16.5-18.8 av. 17.7 17-21	44-51 av. 47.9 46-53)
Bhutan (5)	66-74av. 69.6	10.5-11.5 av. 10.9	17.5-19 av. 18	45-49 av. 47.2
Passer flaveolus EL				
Males (5)	68-74 av. 69.8 (Baker 69-75	10. 1 -11.2 av. 10. 8 11-12	17.1-20 av. 18.7 c. 17	48-54 av. 50.8 52-54)
Females (2)	67,68	10.3,10.9	17.5,17.7	48, 49
1948-49 *Petronia xanthocollis* subspp.				
Males				
1948 *transfuga* (14)	77-86 av. 81.2 (IH M/F 80-86	10.5-12 av. 11.3 froin skull 15-16	15 - 19.5 av. 16.6 c. 15	48-55 av. 51.2 47-53)
1949 *xanthocollis* (27)	71-86 av. 80.8 GH 77-89	11-13 av. 11.89 from skull 13-16	15-16.5 av. 15.58 16-18	46-54 av. 49.9 46-52)
Females				
transfuga (6)	76-80 av. 78.8	11-12 av. 11.4	16-17.5 av. 16.6	48-52 av. 49.6
xanthocollis (16)	75-80 av. 77.1 (IH 76-85	11-12.5 av. 11.5 from skull 13-16	14-16 av. 15 16-18	44-50 av. 47.4 43-55
1950 *Petronia petronia intermedia*				
Males (2)	100,101 (IH M/F 98-104	13.5,14.3 from skull c. 18	18,18.5 18-19	54,56 57-60)
Female (1)	95	14	18	53

TABLE 1 (CONTD.)
MEASUREMENTS OF THE BIRDS IN THE COLLECTION OF BNHS

	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
	Petronia brachydactyla EL			
Males (2)	91,97 (Dement'ev 90-100)	11.5,12.2	18,18.5	43.52
Female (1)	95 (Dement'ev 86, 90)	14	18	53
	1952 *Montifringilla adamsi adamsi*			
Males (3)	107,111(2) (IH 109-117	12.4,12.5,12.7 from skull. 16-17	20(2),21 21-22	65,68,71 66-75)
Female (1)	107 (IH 106-113	13.2 from skull 16-17	21.5 21-22	66 66-75)
	1955 *Montifringilla blanfordi blanfordi*			
Female (1)	92 (IH M/F 90-97	10.5 c. 10-11	17.5 c. 19-20	51 54-56)

pale, almost like an albino.

Measurements on p. 238.

1949 ***Petronia xanthocollis xanthocollis* (Burton)** (Ganges between Calcutta and Benares) Indian yellowthroated sparrow

51: 27 males, 16 females, 8 unsexed.

2 Delhi, 1 Bulandshahr, U.P., 2 Bharatpur, Rajasthan, 1 Nadiad, Kaira, 1 Bodeli, 1 Dabka, Baroda, 1 Pandwa, 1 Malegaon, Surat Dangs, 1 Saugar, 1 Raipur, Melghat, Berar, 1 Golapally Bastar, 1 Manthar, Narbada Valley, 3 Rita, Murbad Road, Kalyan, 4 Bhiwandi, Thana dist., 1 Poona, Deccan, 1 Karwar, 2 N. Kanara, 1 Kadra, Kanara, 2 Lingadhalli, 1 Murgimatta, 1 Talguppa, 1 Gamataghatta, 1 Sagar, Mysore, 1 Kuruvenulti, Travancore, 1 Madurai, 2 Gingee, S. Arcot, 1 Redwells, Madras, 1 Maidapur, Angul, 1 Daspalla State, 1 Tikerpara, Bangul dist., 7 Barkot, 1 Badrama, Bamra, 1 Baud, Orissa, 2 Baghownie, Tirhut, Bihar.

9 males collected in February and 5 in March have their bills black, especially the lower mandibles; the rest of the males were collected in November, December and January, the bills are brown except in one skin dated 12th January and 2 dated 26th January. In females, the bills are brown, shoulder patch and yellow throat patch are so pale as to go unnoticed. Out of the 8 unsexed, 7 are males by plumage and measurements.

Measurements on p. 238.

1950 ***Petronia petronia intermedia* Hartert** (Gilgit). Rock sparrow. 3: 184

3: 2 males, 1 female.

1 Kidri, 2 Tigab, Nr. Kain, Persia.

Measurements on p. 238.

EL ***Petronia brachydactyla* Bonaparte**, Western Arabia. Short-toed rock sparrow (desert rock sparrow).

4: 2 males, 2 females.

2 Fatah, Tigris, 2 Charbar, Baluchistan.

These four birds were listed and kept with the earlier species (Synopsis No.) 1950 in the collection, smaller in size than the above, sandy brown without streaks on the back or under parts, yellow throat patch absent, rectrices brown, with narrow white margins on outer webs, turning into a white border on the outermost rectrices. Contrary to the description in the BIRDS OF THE SOVIET UNION Vol 5, p 392, the middle pair of rectrices lack the white patch and the inner borders of the 3 outer rectrices have white triangular markings in descending

order (outermost rectrix has largest marking). Two pale brown wing bars formed by the tips of upper and middle wing coverts. Male and female similar in plumage (very inconspicuous, cryptic colouring, which is probably why this birds' habits are little known and specimens in collections not numerous; B.S.U. Vol. V, 391).

Measurements on p. 239.

1951 ***Montifringilla nivalis alpicola* (Pallas)** Caucasus. Pallas's snow finch.

nil

1952 ***Montifringilla adamsi adamsi* Adams** Ladakh. Tibet snow finch 3: 187

8: 3 males, 1 female, 4 unsexed.

1 Zgunglas, 1 Phobrang, Ladak, 2 Kioto, 1 Losar, Spiti, Kangra dist., 2 Tingri, 1 Thungla, S. Tibet.

Measurements on p. 239.

1953 ***Montifringilla taczanowskii* (Przevalski)** (Tetunga and Kuku Nor Steppe) Mandelli's snow finch 3: 188

nil

1954 ***Montifringilla ruficollis* Blanford**. (Lachen Valley, N. Sikkim). Rednecked snow finch. 3:189

2: 1 juvenile male, from Kyangma, Bakha Plain, W. Thibet and another unsexed from Phail, Tibet.

1955 ***Montifringilla blanfordi blanfordi* Hume** (borders of Tibet to the north of native Sikkim). Blanford's snow finch 3:190

One female from Neypuding above Punga, Ladak.

Measurements on p. 239.

1956 ***Montifringilla davidiana potanini* (Sushkin)**. (Khara-djamaty, basin of Kobdo). Pere David's snow finch.

nil.

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(*To be continued*)

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PITFALL TRAP SAMPLING OF TROPICAL CARABIDS (CARABIDAE : COLEOPTERA) — EVALUATION OF TRAPS, PRESERVATIVES AND SAMPLING FREQUENCY[1]

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Key words: Carabids, sampling, pitfall trap, trap types, preservatives, sampling frequency

Sampling ground beetles (Carabidae : Coleoptera) using pitfall traps was evaluated by comparing combinations of three trap types and five preservatives in a 3x5 factorial randomised complete block design over a period of four months for two sampling intervals namely, a week and a fortnight. Analysis based on the capture efficiencies of different treatment combinations resulted in the recommendation of glass jar pitfall traps (11x6 cm) with formalin (4%) or ethylene glycol (2%) as preservative, with a fortnightly sampling frequency. Preservative efficiency and trap recovery efficiency of traps in the two sampling experiments and the cost factor for using any one trap and preservative combinations of fortnightly sampling in the sampling programme are discussed.

INTRODUCTION

In recent ecological studies, carabids or ground beetles have received increasing attention owing to their frequent occurrence in all varieties of habitats and economic importance in agriculture (Saypulaeva 1986, Luff 1987). They also serve as pedobiological monitors, indicating habitat degradation (Luff *et al.* 1989). Hence, an ecological research study on carabids as potential indicators of environment and/or as economic bioagents, needs the development of a comprehensive, economical and environmentally suitable system of sampling.

Pitfall trapping sampling method has been found reliable to assess qualitative and quantitative species composition of carabids simultaneously in several habitats (Dennison and Hodkinson 1984). Pitfall traps were preferred to quadrats, as the latter has proven unserviceable (Loreau 1984). Many workers, therefore, used some form of pitfall trapping to monitor and assess populations of carabids (Mitchell 1963, Greenslade 1964, Sunderland 1975, Halsall and Wratten 1988). The effectiveness of pitfall traps reportedly depends on the material of construction, presence of a preservative and its chemical composition, number of traps and how often the traps are checked (Gryuntal 1982). So, as a prerequisite for sampling tropical carabids to study their species diversity, the present study attempts to evaluate the types of traps, preservatives and sampling frequency.

MATERIAL AND METHODS

Two experiments namely, weekly and fortnightly sampling experiments, each of Factorial Randomised Complete Block Design (FRCBD) with two replications each, were laid out simultaneously in two adjacent areas of an agroforest, each of 15,000 sq. m, to compare three trap types: glass jar (11x6 cm), aluminium tumbler (11x6.5 cm) and plastic tumbler (11x6 cm); and four preservatives: formalin (4%), ethylene glycol (2%), salt solution (20%) and detergent solution (2%). Traps without preservatives (empty traps) were also tested, hence there were 3x5 factorial combinations in

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two replications of each of the sampling experiments.

Traps were set in the soil with their position as per random allotment in FRCBD, with their opening flush with the soil surface. Measured quantities (50 ml) of preservatives were poured as directed by the sampling plan. Traps were checked once in three days to refill traps with preservatives, if required. Sampling was carried out for a period of four months with fifteen weekly and seven fortnightly collections.

The total catches of carabids, irrespective of species (measure of capture efficiency), for the three trap types with five preservatives over two replications were recorded for the two sampling programs. Also, the number of specimens that were well preserved (measure of preservative efficiency), number of times each preservative needed to be replenished during the sampling period (measure of cost and time efficiency), and number of traps that could be recovered for reuse at the end of the experimental period (measure of trap recovery efficiency) were made for the weekly and fortnightly experiments separately.

Statistical analysis

Weekly and fortnightly sampling experiments of FRCBD were analysed separately to answer three explicit questions: whether carabid catches indicate significant differences (a) among trap types (b) among the type of preservatives and (c) for interactive effects between trap types and preservatives.

Total number of carabids caught at the end of the experiment from two sampling periods was tested using student 't' test. The efficiency of preservatives in terms of number of carabid specimens recovered for further handling and efficiency of traps in terms of number of traps reusable between two sampling experiments were tested using chi square test. One way analysis of variance was used to detect differences among preservatives for frequency of replenishing.

Cost analysis for using any trap type with any preservative was done, taking into account the total number of traps used and total quantity of preservatives used, for the fortnightly sampling experiment.

Results

The analysis of variance (ANOVA) for carabid catches of weekly and fortnightly sampling experiments based on the FRCBD analysis are shown in Tables 1 and 2, respectively.

Table 1
ANOVA FOR TOTAL WEEKLY CATCHES OF CARABIDS

Source of variation	Degree of freedom	Sum of squares	Mean square	Computed 'F'
Replication	1	5.63	5.63	0.287 NS
Treatment	14	1908.47	136.32	6.943**
Trap (T)	(2)	1048.67	524.33	26.710**
Preservative (P)	(4)	452.13	113.03	5.757**
(T) x (P)	(8)	408.27	51.03	2.590NS
Error	14	274.87	19.63	
Total	29	2188.97		

**: Significant at $P < 0.01$, NS: Not significant

Table 2
ANOVA FOR FORTNIGHTLY CATCHES OF CARABIDS

Source of variation	Degree of freedom	Sum of squares	Mean square	Computed 'F'
Replication	1	192.53	192.53	10.67**
Treatment	14	2542.20	181.59	10.07**
Trap (T)	(2)	680.00	340.00	18.86**
Preservative (P)	(4)	1300.00	325.00	18.03**
(T) x (P)	(8)	562.20	70.28	3.89*
Error	14	252.47	18.03	
Total	29	2987.20		

**: Significant at $P < 0.01$, *: Significant at $P < 0.05$

While the main treatment effects, namely traps and preservatives, showed significant differences in both sampling experiments, their interaction effect was significant only for the fortnightly

sampling experiment. Capture efficiency was significantly higher in glass trap and on par for all preservatives in both the experiments (Table 3). For the fortnightly sampling experiment, comparison of capture efficiencies among traps for preservatives (Table 4) showed on par capture when traps were left empty, and highest capture for all preservatives when used with glass jar. Comparison of capture efficiencies among preservatives for different trap types (Table 5) had shown no differences in carabid capture when any preservative was used with aluminium and plastic traps. Glass traps with formalin as preservative had the highest catch.

TABLE 3
CAPTURE EFFICIENCIES* FOR TRAPS AND PRESERVATIVES OF WEEKLY AND FORTNIGHTLY SAMPLING EXPERIMENTS

Treatment comparison	Sampling experiment**	
	Weekly	Fortnightly
For traps		
Glass jar	28.2a	23.6a
Aluminium tumbler	17.1b	12.6b
Plastic tumbler	14.6c	13.4b
For preservatives		
Empty	12.3a	3.2a
Formalin	21.0b	21.7b
Ethylene glycol	22.7b	19.2b
Salt solution	22.7b	19.6b
Detergent solution	21.2b	19.0b

* Mean carabid catches over study period
** In a column, means followed by a common letter are not significantly different at P < 0.05

Comparison of carabid capture efficiencies between sampling experiments for trap types (Table 6) indicated significant differences corresponding to empty traps alone, with catches four times higher in weekly than those in fortnightly sampling experiment. Preservative efficiency varied between the experiments only for inorganic preservatives, namely salt and detergent solutions, with larger catches recorded in weekly sampling experiment (Table 7). Frequency of replenishment was the least in ethylene glycol and highest in formalin (Table 8). Recovery of plastic traps alone was significantly lower in weekly than in fortnightly sampling experiment (Table 9). Glass type traps used with any preservative (Table 10) in the fortnightly sampling experiment were least expensive.

TABLE 4
COMPARATIVE EFFICIENCY OF TRAP TYPES WITH DIFFERENT PRESERVATIVES

Preservative**	Trap type		
	Glass jar	Aluminium tumbler	Plastic tumbler
Empty	2.5a	4.0a	3.0a
Formalin	36.0a	14.5c	15.5b
Ethylene glycol	22.5a	15.5c	19.5b
Salt solution	28.0a	14.5c	16.5b
Detergent solution	29.0a	14.5b	13.5c

* Mean carabid catches over study period
** In a row, means followed by a common letter are not significantly different at P < 0.05

TABLE 5
COMPARATIVE EFFICIENCY OF PRESERVATIVES WITH DIFFERENT TRAP TYPES

Preservative**	Trap type		
	Glass jar	Aluminium tumbler	Plastic tumbler
Empty	2.5d	4.0b	3.0b
Formalin	36.0a	14.5a	15.5a
Ethylene glycol	22.5c	15.5a	19.5a
Salt solution	28.0bc	14.5a	16.5a
Detergent solution	29.0b	14.5a	13.5a

* Mean carabid catches over study peirod
** In a column, means followed by a common letter are not significantly different at P < 0.05

DISCUSSION

Effect of type of traps and preservatives: Significantly higher capture efficiency for glass

TABLE 6
CAPTURE EFFICIENCIES* BETWEEN SAMPLING EXPERIMENTS FOR TRAPS

Trap type	Sampling experiment		Test of significance (t value)
	Weekly	Fortnightly	
Glass jar	31.75	28.88	1.099^{NS} (n=8)
Aluminium tumbler	17.63	15.00	1.132^{NS} (n=8)
Plastic tumbler	16.13	16.00	0.045^{NS} (n=8)
Empty trap	12.33	3.17	6.087^{NS} (n=8)

* Mean carabid captures over study period
^{NS}: Not Significant, **: Significant at P<0.01

TABLE 7
PRESERVATIVE EFFICIENCIES BETWEEN SAMPLING EXPERIMENTS

Preservative	Sampling experiment		Test of significance (χ^2 value)
	Weekly	Fortnightly	
Formalin	92 (126)	89 (130)	0.942^{NS}
Ethylene glycol	88 (136)	86 (115)	0.259^{NS}
Salt solution	76 (136)	59 (118)	7.836**
Detergent solution	53 (127)	28 (116)	15.908**

* Percentage of carabids recovered for further handling

Figures within parentheses are the total number of carabids caught during the experiment

^{NS}: Not Significant, **: Significant at P < 0.01

jar traps over aluminium and plastic traps from both the weekly and fortnightly sampling experiments revealed the superiority of glass jars for sampling carabids. The effectiveness of glass traps over polythene traps for carabid sampling has been reported by Gryuntal (1982). Although formalin has been reported to have an attractant effect (Luff 1968), the present study did not show difference in catches among preservatives. Irrespective of trap types, empty traps (any trap type without preservative) always registered lower carabid catches. Catches were lower in fortnightly than in weekly sampling experiment. Lower capture efficiency of empty traps can be explained, firstly by the general ability of smaller carabids to climb out of traps; secondly, by the devouring of smaller carabids by larger ones, and

TABLE 8
MEAN FREQUENCY OF REPLENISHMENT FOR PRESERVATIVES

Preservative	Mean frequency of replenishment*
Formalin	22.5b
Ethylene glycol	12.0a
Salt solution	17.0ab
Detergent solution	18.3b

* Means followed by a common letter are not significantly different at P < 0.05

TABLE 9
RECOVERY EFFICIENCY* FOR TRAPS BETWEEN SAMPLING EXPERIMENTS

Trap type	Sampling experiment		Test of significance (χ^2 value)
	Weekly	Fortnightly	
Glass jar	19	18	0.360^{NS}
Aluminium tumbler	17	16	0.173^{NS}
Plastic tumbler	10	16	3.956*

* Number of traps recovered at the end of experiment out of 25
^{NS}: Not Significant, **: Significant at P < 0.05

TABLE 10
EXPENDITURE FOR TRAP-PRESERVATIVE COMBINATIONS IN FORNIGHTLY EXPERIMENT

Preservative	Trap type		
	Glass jar	Aluminium tumbler	Plastic tumbler
Formalin	34.01	83.90	38.11
Ethylene glycol	31.34	55.44	35.44
Salt solution	30.29	54.39	34.39
Detergent solution	30.27	54.37	34.37

* Figures denote the total expenditure (rupees) incurred during the sampling experiment taking into account trap and preservative life

thirdly, by the susceptibility of catches to predation by other groups such as lizards, rodents etc. The lesser efficiency of empty traps alone in fortnightly than in weekly sampling experiment suggests that increased time invigorates the above three factors. Luff (1975) found that glass traps could retain catches without the use of

preservatives better than metal and plastic traps. The present study, however, finds that preservatives are a must for trapping carabids in the tropics.

All preservatives, whether organic (formalin, ethylene glycol) or inorganic (salt, detergent solutions) showed higher effectiveness when used with glass jars. However, formalin used with glass jars recorded highest capture efficiency, indicating the supremacy of glass jars with formalin for carabid sampling. Greater impediment to insect movements on the glass surface, and the well known fixative effect of formalin appear to be the reasons for the greater efficiency of glass jars with formalin for sampling carabids.

Effectiveness of preservatives: While organic preservatives (formalin, ethylene glycol) had not differed in efficiency expressed as the number of carabid specimens recovered for further handling, the inorganic preservatives (salt, detergent solutions) had lesser catches of carabids. This might be due to the fixative properties of organic preservatives. It was observed that a larger number of specimens separated out had heads detached from their bodies and an offensive smell, hampering the separation process, from inorganic preservatives in the fortnightly sampling experiment. This indicates that biodegradation sets in at traps with salt or detergent solutions with a long sampling interval, and their unsuitability as preservatives for more than a week's sampling frequency.

The time factor analysis on preservatives based on mean frequency of replenishing shows that ethylene glycol and salt solution required more frequent replenishment than formalin and detergent solution. This is due to the differential evaporation rate of preservatives tested. Adis (1979) has reported lower evaporation rate of ethylene glycol in pitfall traps.

Recovery efficiency of traps: Recovery of a smaller number of plastic pitfall traps in weekly sampling experiment than in the fortnightly sampling experiment is attributed to the lesser resistance offered by the traps to frequent replacements. With glass jar and aluminium tumbler traps, the loss of traps was negligible in both experiments.

Sampling cost for trap and preservative combinations: Expenditure incurred for the fortnightly sampling experiment alone was calculated, as the interaction effect of traps and preservatives was significant for that sampling frequency. It was seen that, for any preservative used with glass jar, the costs are the least and with aluminium trap the highest.

With the salt and detergent solutions proving unsuitable among preservatives and glass jar superior among trap types, cost benefit analysis is valid only between the use of formalin and ethylene glycol with glass jar traps. The difference was small (Rs. 34 for glass jar with formalin, and Rs. 31 for glass jar with ethylene glycol) suggesting that choice can depend on availability.

Overall perspective of the developed sampling programme: On the basis of this study the use of glass jar (11x6 cm) traps with formalin (4%) or ethylene glycol (2%) as preservative with a sampling frequency of a fortnight is recommended to be cost effective for studies of distributional limits and to measure their dynamic relations with the environment.

Acknowledgement

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NEW DESCRIPTIONS

BARILIINE FISHES OF MANIPUR, INDIA, WITH THE DESCRIPTION OF A NEW SPECIES: *BARILIUS LAIROKENSIS*[1]

LAIFRAKPAM ARUNKUMAR[3] AND HIJAM TOMBI SINGH[2]

(*With one text-figure*)

Key words: *Barilius lairokensis* sp. nov., Manipur

The systematic account of bariliine fishes of the genus *Raiamas* and *Barilius* hitherto known from the state of Manipur, India, namely *R. bola* (Hamilton-Buchanan), *R. guttatus* (Day) and *B. barila* (Ham.-Buch.), *B. barna* (Ham.-Buch.), *B. bendelisis* (Ham.-Buch.). *B. dogarsinghi* Hora, *B. gatensis* (Valenciennes), *B. tileo* (Ham.-Buch.) and *B. vagra* (Ham.-Buch.) are given. A new species, *B. lairokensis* has been described here. It resembles *B. barila* in its external morphology, but differs from it in the depth of body, non-extended maxilla and predorsal scales.

INTRODUCTION

Manipur is a hill-bound state in northeastern India. The drainage system of this state may be grouped into three, namely the Barak, the Manipur and the Yu river systems. The Barak river system drains the western sides of this state and finally joins the Brahmaputra river. Both, the Manipur river system which drains the central valley and the Yu river system which drains the major hilly eastern sides of this state, directly join the Chindwin river of Myanmar. Each of the three river systems has its own distinctive ichthyofauna.

The bariliine fishes of the genera *Raiamas* and *Barilius* are widely distributed throughout India, Sri Lanka, Myanmar, Shan State, Thailand, China, Cambodia (Khmer Republic), Korea, Honshu Island of Japan, Amur basin, Africa, Malay Peninsula and Southeast Asian Archipelago.

The description of *Barilius dogarsinghi* by Hora (1921) and the collection of *Barilius guttatus* by Menon (1952) are the most important records of bariliine fishes in Manipur. Menon (1954, 1974), Singh and Tombi Singh (1985) and Tombi Singh (1992) did not give a precise picture of the localities and distribution of these fishes in Manipur.

A detailed survey of the ichthyofauna of the state was carried out. Fifteen specimens of *Barilius* were collected from the Yu drainage system, and when compared with known species of this genus, appeared to be hitherto undescribed. These specimens are described in this communication as a new species, *Barilius lairokensis*.

MATERIAL AND METHODS

Fishes were collected from hill streams of the three drainage systems of Manipur, namely the Barak river, the Manipur river and the Yu river, with the help of local fishermen using: by-side tracking, dewatering shallow portions of the streams, with nets, hook and line. Identification of the species was done with reference to Barman (1985), Day (1989), Talwar and Jhingran (1991) and Howes (1980, 1983). The meristic and morphometric measurements were made following standard techniques described by Jayaram (1981), Barman (1985), Menon (1987) and Talwar and Jhingran (1991). The specimens are deposited in the Manipur University Museum

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of Fishes (MUMF). Uncatalogued bariliine fishes of MUMF were also observed.

Results

Systematic accounts of the bariliine fishes of Manipur of the genus *Raiamas* (2 species), *Barilius* (7 species) and a new species, *Barilius lairokensis*, along with their distribution in Manipur are given below:

Raiamas bola (Ham.-Buch.)

Cyprinus bola Ham.-Buch. 1822, *Fish. Ganges.*, 274, 385 (type locality: Brahmaputra river).

Material: 5 exs. Uncat. MUMF. 2 from Barak river at Barak Bridge, 169-248 mm total length, 5.ix.1995. Uncat. MUMF. 3 from Chakpi stream at Serou, 196-248 mm total length, 19.vi.1996. 1 Uncat. MUMF. 142 mm total length, coll. R. Singh.

Local name: Ngawa

Distribution: Manipur: Barak river system, Manipur river system.

Remarks: *R. bola* is an endangered fish (Menon 1990). Kulkarni (1992) reported that it was presently rather rare in its natural habitat and may become extinct.

Raiamas guttatus (Day)

Opsarius guttatus Day, 1889, *Proc. Zool. Soc. Lond.*, 620 (type locality: Irrawady river, from Prome to Mandalay, Burma).

Material: 5 exs. Uncat. MUMF. 2 from Sekmai stream, Pallel, 50-165 mm total length. 3 from Chakpikarong, 162-200 mm total length, 14.x.1981, coll. W.V., 2 exs. Uncat. MUMF from Imphal river at Khongnangfeidekpi, 175-182 mm total length, 6.iv.1989, coll. L.A., 2 exs. Uncat. MUMF. 1 from Lokchao river and 1 from Moreh Bazar, 192-212 mm total length, 17.x.1992, coll. L.A.

Local name: Ngawa-thangong.

Distribution: Manipur: Manipur river system, Yu river system.

Remarks: Largest and tastiest bariliine fish in Manipur. It is available in the central valley of Manipur, exhibiting upward migration from the Chindwin river of Myanmar.

Barilius barila (Ham.-Buch.)

Cyprinus barila Ham.-Buch. 1822, *Fish Ganges.*, 267, 384 (type locality: Northern Bengal).

Material: 9 exs. Uncat MUMF. 6 from Makru river, 93-98 mm total length, 3 from Taret stream, 93-102 mm total length, 24.ii.1985, coll. M.G. Sharma., 3 exs. Uncat. MUMF, from Imphal river at Kangpokpi, 97-99 mm total length, 7.vii.1989, coll. L.A., 2 exs. Uncat. MUMF, from Thoubal river at Yairipok, 94-163 mm total length, 15.vii.1989, coll. L.A.

Local name: 'Ngawa' in Meitei / Manipuri language, 'Bakba' in Maring Naga language.

Distribution: Manipur: Barak river system, Manipur river system and Yu river system.

Remark: Mukerji (1934) discussed the conspecific relations of *B. barnoides* and *B. barila*.

Barilius barna (Ham.-Buch.)

Cyprinus barna Ham.-Buch. 1822, *Fish Ganges.*, 268, 384. (type locality: Yamuna river, Brahmaputra river).

Material: 18 exs. Uncat. MUMF. 3 from Chakpi stream, 120-122 mm total length, 2.viii.1985, 6 from Makru river, 121-124 mm total length, 15.ii.1986, 9 from Litan stream, 120-125 mm total length, 7.vi.1986, coll. M.G. Sharma., 3 exs. Uncat. MUMF, from Irang river, 122-23 mm total length. 21.iii.1987, coll. R. Singh., 1 ex. Uncat MUMF, from Taret river 95 mm total length, 22.x.1992, coll. L.A.

Local name: Ngawa

Distribution: Manipur: Barak river system, Manipur river system and Yu river system.

Remark: Sexual dimorphism of this species was reported by Mukerji (1934). *B. jayarami* is the synonym of *B. barna* (Talwar and Jhingran, 1991).

Barilius bendelesis (Ham.-Buch.)

Cyprinus bendelisis Ham.-Buch. 1807, *Journey in Mysore, 345,* 32, (type locality: Vedawati stream, head waters of Krishna river near Heriuru, Mysore).

Material: 11 exs. Uncat. MUMF, from Barak river, 71.5-125 mm total length, 12.i.1985, coll. M.G. Sharma, 1 ex. Uncat. MUMF, from Barak river at Duifain stream, southern side of Zhiliad lake, 32 mm total length, 8.ii.1997, coll. L.A. and Tombi Singh.

Local name: Ngawa/Ngawa-phurithungbi.

Distribution: Manipur: Barak river system - Senapati stream at Karong, Leimatak river, Irang river, Makru river, Barak river at Nungba, Zhiliadjang, Bangaijang, Keimai.

Remarks: Its distribution in Manipur is restricted to Barak river system. Talwar and Jhingran (1991) synonymised *B. howesi* with *B. bendelisis*.

Barilius dogarsinghi Hora

Barilius dogarsinghi Hora, 1921, *Rec. Ind. Mus.*, 191, 3 (type locality: Etok stream near Chandrakhong and Sekmai stream near Pallel, Manipur).

Material: 15 exs. Uncat. MUMF, 14 from Chakpi stream, Mombi, 50-105 mm total length, 16.ix.1981, 1 from Sekmai stream, Pallel, 16.v.1981 (Condition bad), coll. W.V., 14 exs. Uncat. MUMF, 10 from Taret stream, 50-95 mm total length. 17.x.1992, 4 from Lokchao stream, 100-115 mm total length. 15.xii.1995, coll. L.A.

Local name: Ngawa / Ngawa-apakpi.

Distribution: Manipur: Manipur river system - Thoubal river at Yairipok. Yu river system: Tarest stream at Saibol, Lokchao river at Lokchao, Lairok Maru.

Barilius gatensis (Valenciennes)

Leuciscus gatensis Valenciennes, 1844, *Hist. nat. poiss.*, 309, 503. (type locality: peninsular India).

Material: 4 exs. Uncat. MUMF, from Chakpi stream, Chakpikarong, 90-123 mm total length, 14.x.1981, coll. W.V., 1 ex. Uncat. MUMF from Imphal river at Khongnangfeidekpi, 85 mm total length, 5.viii.1988, coll. L.A.

Local name: Ngawa.

Distribution: Manipur: Manipur river system.

Barilius tileo (Ham.-Buch.)

Cyprinus tileo Ham.-Buch. 1822, *Fish. Ganges.*, 276, 385 (type locality: Kosi river, Uttar Pradesh).

Material: 2 exs. Uncat. MUMF, from Jiri river at Jiri, 150-175 mm total length, 2.ii.1991, coll. R. Singh.

Local name: Ngawa.

Distribution: Manipur: Barak river system.

Barilius vagra (Ham.-Buch.)

Cyprinus vagra Ham.-Buch. 1822, *Fish Ganges*, 269, 385 (type locality: Ganges river at Patna).

Material: 2 exs. Uncat. MUMF, from Imphal river at Motbung, 95-106 mm total length, 16.vi.1993, coll. L.A., 1 ex. Uncat. MUMF, from Jiri river at Jiribam. 97 mm total length, 21.vii.1994, coll. R. Singh.

Local name: Ngawa.

Distribution: Manipur: Barak river system, Manipur river system - Sanahal Lokchao, Litan stream at Litan, Thoubal river at Yairipok.

Barilius lairokensis sp. nov.
(Fig. 1)

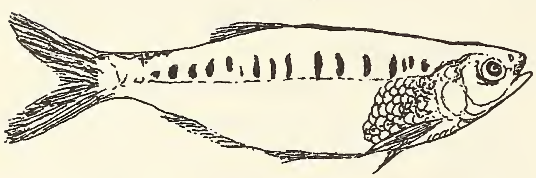

Fig. 1: *Barilius lairokensis* sp. nov. MUMF 3700/1A, Holotype, 87 mm, SL, Lairok Maru. Stream of the Yu drainage system.

Material: 15 exs. Holotype-MUMF 3700/1A, TL 110 mm, SL 87 mm, from Lairok Maru, Moreh, Chandel district, Manipur, 17.x.1992. Coll. Laifrakpam Arunkumar. Paratypes-MUMF 3700/14A, TL 106 mm, SL 81-82 mm, from Moreh Bazar, Moreh, Chandel district, Manipur, 17.x.1992, Coll. L.A.

Local name: Ngawa.

Diagnosis: A *Barilius* having the combination of following distinct characters: 14 to 16 dark lateral bands. Predorsal scales 21; lateral line scales 44, lateral line transverse 9.5/3.5; 2 pairs of barbels; depth of body 25.97 to 29.94; 19.84 to 23.64; and length of head at the end of lateral operculum 25.31 to 25.97; 19.84 to 20.00 in the percentage of standard length and total length respectively. Height of caudal peduncle 56.49 to 64.51 in its length. Maxilla just reaches the anterior margin of orbit.

Description: Br. 3 to 4, D. ii. 8, P. I. 13, V. I. 8, A ii. 11, C. 19. Body shallow, laterally compressed, mouth moderate, rostral and maxillary barbels short. Tip of snout and lower jaw poorly tuberculated. Dorsal fin placed entirely in advance of anal fin. Pectoral fin is less than the length of head at the lateral end of operculum. Caudal fin forked, lower lobe longer than the upper lobe. Scales moderate. Lateral line downwardly curved.

Proportional measurements of holotype and paratypes (in parentheses): Length of head of occiput 14.55 (13.21 to 14.16) in the percentage of total length and 18.83 (17.30 to 18.31) in the percentage of standard length. Predorsal length 56.49 (57.47 to 58.13), prepelvic length 52.91 (50.76 to 52.63), preanal length 75.18 (71.94 to 74.62), length of dorsal fin 19.56 (19.53 to 19.76), length of pectoral fin 19.56 (20.74 to 21.00), length of pelvic fin 13.79 (13.42 to 13.58), length of anal fin 14.94 (13.09 to 15.30), length of upper caudal fin 22.98 (23.20 to 24.17), length of lower caudal fin 26.45 (25.31 to 28.86), width of body at dorsal fin origin 12.65 (10.97 to 11.11) and width of body at anal fin origin 9.19 (8.53 to 8.64) in the percentage of standard length respectively. Length of head at occiput 72.99 (69.66 to 71.42), length of snout 31.84 (28.57 to 32.14), diameter of eye 27.32 (26.80 to 27.42), interorbital distance 27.32 (27.92 to 33.33), length of pectoral fin 77.51 (76.92 to 81.30), depth of head at occiput 81.96 (79.42 to 79.33), width of head at nares 27.32 (23.80 to 28.57), width of head at neck 45.45 (42.91 to 47.51), width of mouth 31.84 (29.80 to 32.57), length of rostral barbel 9.09 (8.76 to 9.52), and length of maxillary barbel 13.64 (14.76 to 15.52) in the percentage of length of head at the end of lateral operculum respectively. Distance from pelvic to anal opening 95.23 (88.49 to 95.23) in the percentage of distance between pelvic and anal fin origin.

Colour: Dorsal fin blackish. Tip of caudal fin black and of other fins pale white with no markings. Dorsal greenish-brown. Whitish ventrally. Lateral bands do not touch lateral line. Two black spots are present in the back of caudal peduncle in mature specimens.

Remarks: *Barilius lairokensis* sp. nov. differs from *B. barila* in having greater depth of body (25.97% to 29.94% vs. 20.83% to 21.73% in standard length), fewer predorsal scales (21 vs. 22), extension of maxilla (just reaching vs. extends to below anterior third of orbit) and extension of lateral bands (not reaching vs. reaching lateral line).

Etymology: The specific name of the fish is derived from the type locality Lairok Maru stream.

Discussion

Hora (1921) doubted the inclusion of *B. dogarsinghi* in the present genus *Barilius* because of the absence of the symphyseal knob in the lower jaw. Singh and Tombi Singh (1985) wanted to create a subgenus for *B. dogarsinghi*. *B. guttatus* was at first regarded as a new record from India (Singh and Tombi Singh 1985). Tombi Singh (1992) recorded *B. tileo* as a new record from Manipur.

The bariliine fishes of Manipur may be divided into two main genera, viz., *Raiamas* and *Barilius*. The genus *Barilius* of Manipur may also be further divided into two groups, namely *barila* group and *gatensis* group according to the number of barbels, development of tubercles, short or long jaws and depth of body. *B. barna*, *B. gatensis* and *B. tileo* belong to the *gatensis* group, while *B. barila, B. bendelisis, B. dogarsinghi, B. vagra* and *B. lairokensis* sp. nov. belong to the *barila* group.

Raiamas guttatus is found in the Manipur river system and the Yu river system only of Manipur. *B. bendelisis*, *B. gatensis* and *B. lairokensis* sp. nov. are the important distinctive bariliine fishes distributed in the three different river systems of Manipur, namely Barak river, Manipur river and Yu river respectively.

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TWO NEW SPECIES OF *COPIDOGNATHUS* (HALACARIDAE : ACARI) FROM KERALA[1]

TAPAS CHATTERJEE[2]

(*With seventeen text-figures*)

Key words: Halacaridae, Acari, *Copidognathus*, new species, Kerala

Two new species of Halacaridae (Acari), *Copidognathus keralensis* and *C. balakrishnani* are reported here from Kovalam coast and Cochin backwaters respectively. Both species were collected among phytal samples.

INTRODUCTION

Four species of Halacaridae, namely *Copidognathus sideus* Bartsch, *Arhodeoporus bonairensis* Viets; *Rhombognathus papuensis* Bartsch, and *R. scutulatus* Bartsch, have been reported by me from Kerala (Chatterjee and Sarma 1993, Sarma and Chatterjee 1993, Chatterjee 1995)

In the present communication, two new species of the genus *Copidognathus* are reported here from Kerala.

Abbreviations used in the text: AD- anterodorsal plate, AE- anterior epimeral plate, OC- Ocular plate, PD- Posterodorsal plate, PE- Posterior epimeral plate, GA- Genitoanal plate, GO- Genital opening, PGS- Perigenital seta, SGS- Subgenital seta, PAS- Parambulacral seta, EP I- Epimeral process I.

Copidognathus keralensis sp. nov.
(Figs. 1-9)

Locality: Males and females are encountered among different algae from Kovalam beach, Kerala.

Type: Holotype (♂), allotype (♀) will be deposited in the National Pusa Collection, Entomology Division, IARI, New Delhi.

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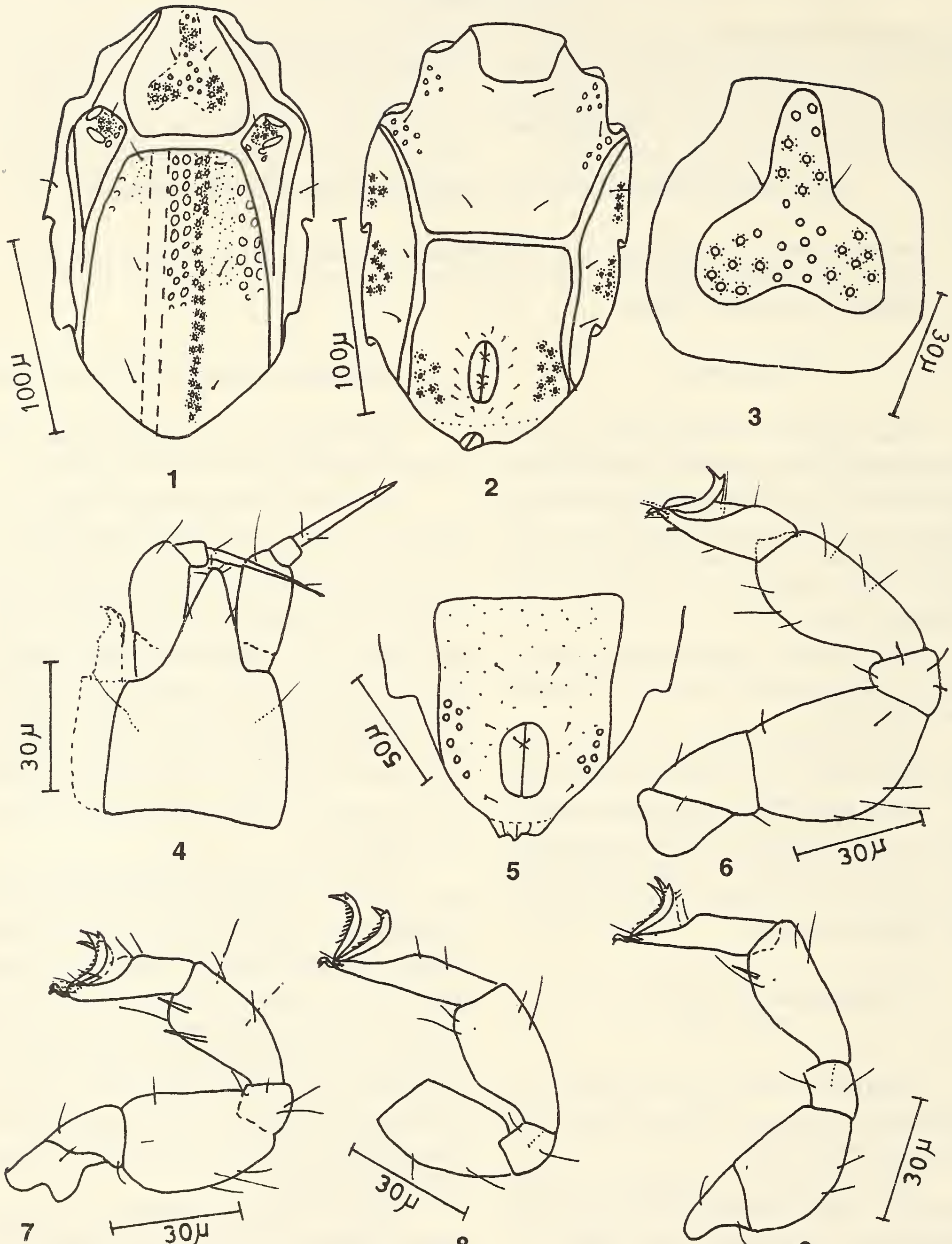
Etymology: Named after the type locality Kerala.

Description: MALE: The idiosomal length of males ranged between 200 and 240 µm.

All dorsal plates are separate (Fig. 1). AD bears an inverted funnel-shaped areola (Fig. 3). The ds_1 is located at the base of the stem of inverted funnel and ds_2 on anteromedian margin of OC. Two distinct corneae are present on OC anteriorly. A few rosette pores present between the two corneae. OC is caudiform posteriorly and extends halfway between the insertion of legs III and IV. PD bears two costae which are two pores wide. The ds_3, ds_4 and ds_5 are located on the anterior, middle and posterior areas of PD respectively.

All ventral plates are separate (Fig. 2). AE does not bear any areolae. AE with 3 setae. EP I moderately developed and blunt anteriorly. EP I coxal in origin. PE bears 3 ventral and 1 dorsal seta besides 2 ventral areolae, made up of rosette pores located in the anterior and posterior regions. GA with paragenital areolae made up of rosette pores. GO is guarded by a pair of sclerites. Three pairs of SGS are present in GO (one anteriorly and two posteriorly). 8-10 pairs of PGS are present.

Rostrum extends more than 2/3 of the length of palpal femur. Gnathosoma bears areolae made up of rosette pores ventrolaterally. Dorsal portion of gnathosoma is panelled. A pair of proto-, deuto, trito- and basirostral setae are present on gnathosoma. Palp 4-segmented (Fig. 4). Palpal



Figs. 1-9: *Copidognathus keralensis* sp. nov.
1. idiosoma dorsal (♂); 2. idiosoma ventral (♂); 3. magnified view of AD; 4. gnathosoma; 5. GA of ♀; 6. leg I; 7. leg II; 8. leg III (Basifemur-tarsus); 9. leg IV (Telofemur-tarsus).

trochanter and patella without setae, palpal femur with one dorsal seta. Palpal tibiotarsus bears 3 setae basally and a singlet eupathidia distally.

Chaetotaxy of legs I-IV is as follows:

Trochanter	1-1-1-0,
Basifemur	2-2-2-2,
Telofemur	5-5-2-2,
Patella	4-4-3-3,
Tibia	7-7-5-5.

Chaetotaxy of tarsus is discussed in the text.

Telofemora III and IV devoid of any ventral setae (Figs. 8, 9), Tibiae I and II with three ventral and four dorsal setae. Tarsus I with 3 dorsal long setae, 1 solenidion, 1 profamulus, 3 ventral setae (one filiform basally and two singlet eupathidia distally) and 4 PAS (two eupathidia doublets) (Fig. 6). Tarsus II bears 3 dorsal long setae, 1 solenidion and 2 PAS (two singlet eupathidia) and no ventral setae (Fig. 7).

FEMALE: The idiosomal length of females ranged between 220 µm and 240 µm. Female resembles the male except for genitoanal region. Three pairs of PGS and a pair of SGS are present (Fig. 5). Ovipositor is small.

Discussion: The present species shares many characters of *Copidognathus oculatus* group of Bartsch (1977).

"A median quadrangular area on the AD, long OC, 2 costae with rosette pores, well developed epimeral process, in females ovipositor surpassing the foramen of the GO. In males, PGS arranged in a corona close to the genital foramen, with a small knob posterior to GO and only three pairs of SGS present, pectinate setae present on all tibiae" (Bartsch 1984) distinguishes the *oculatus* group.

C. keralensis also appears to be akin to the key group 5200 of Newell (1984) due to presence of a well developed EP I, coxal in origin; ds_2 on the anterior margin of OC (in both sexes), a pair of basirostral setae, telofemorae III and IV devoid of ventral setae, and parallel striae present in the membranous area between AD and PD. Considering these attributes, it is possible to assign all the species of *oculatus* group to the key group 5200 but only a few species of the key group 5200 can be assigned to the *oculatus* group, since the key group is an artificial cluster of several unrelated heterogenous species whose characters do not match exactly with the homogenous and natural cluster '*oculatus* group'.

C. keralensis sp. nov. differs from all the species of *oculatus* group and those of key group 5200 in the presence of an inverted funnel-shaped areola of AD. *C. oculatus*, *C. ypsilophorus* and *C. modestus* have more similarities with *C. keralensis* but differ in the shape of posterior areolae of AD. In *C. ypsilophorus*, the inverted Y-shaped areola of AD is deeply concave at its posterior margin and further from posterior margin of AD. In *C. keralensis*, the posterior margin of the inverted funnel-shaped areola is relatively shallower and nearer the posterior margin of AD. The costae of PD are two rosette pores wide in *C. keralensis*, one rosette pore wide in *C. modestus* and 5-7 pores wide in *C. ypsilophorus*. Further, paracostae are absent in *C. keralensis,* but present in *C. ypsilophorus.*

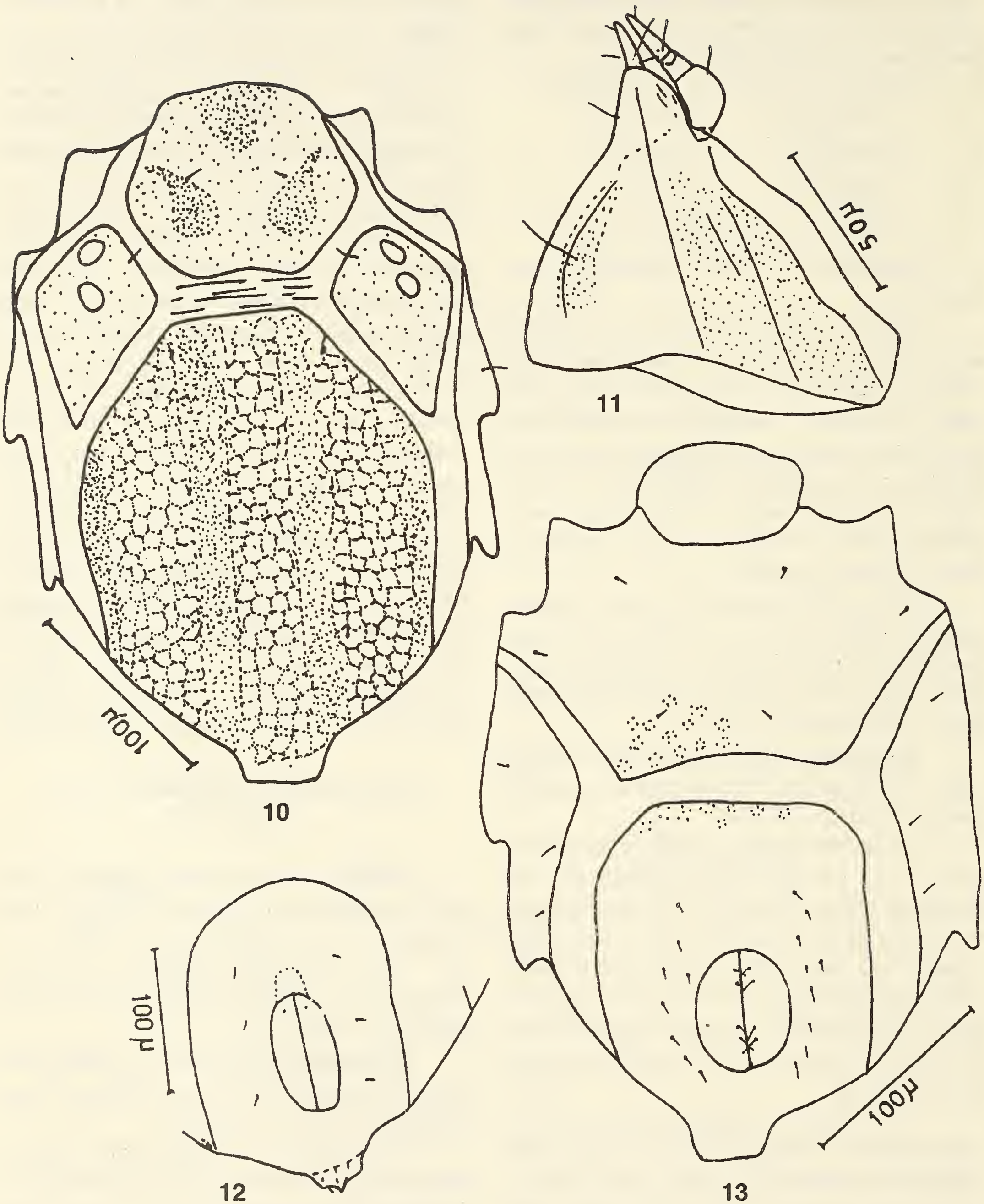
Copidognathus balakrishnani sp. nov. (Figs. 10-17)

Locality: Male and female specimens were encountered among *Enteromorpha* sp. from Cochin backwaters, Kerala.

Type: Holotype (♂) will be deposited in National Pusa Collection, Entomology Division, IARI, New Delhi.

Etymology: Named after Dr. N. Balakrishnan Nair, Department of Aquatic Biology and Fisheries, University of Kerala.

Description: MALE: Idiosomal length of males ranged between 290 µm and 400 µm. All dorsal plates are separate (Fig. 10). AD with an anterior and two posterior (pyriform to circular) faint areolae made up of porose panels. The ds_1 located anterior to the posterior areolae of AD.



Figs.10-13: *Copidognathus balakrishnani* sp. nov.
10. idiosoma dorsal (♂); 11. gnathosoma; 12. GA of ♀; 13. idiosoma ventral (♂).

The ds_2 are placed at the anteromedian part of OC. The OC with two corneae without any areolae, but completely sculptured with panels. PD sculptured with reticulate panel having 4 longitudinal costae made up of porose panels. The ds_3, ds_4 and ds_5 are on the anterior, middle and posterior areas of PD respectively. A pair of adanal setae are present on anal papillae.

All ventral plates are separated by cuticular membranous areas (Fig. 13). Ventral plates without any areolae but sculptured with panels. AE bears 3 pairs of setae and PE bears 3 ventral and 1 dorsal setae. Eight to ten PGS are on each side of the GO. The GO is guarded by a pair of sclerites which bear 4 pairs of SGS. Paragenital areolae are absent but anal papillae are present.

Base of gnathosoma considerably broad (Fig. 11). Rostrum is short and stout, reaching the base of palpal tibiotarsus. A pair of proto-, deuto-, trito-, and basirostral setae are present on gnathosoma. Palp considerably small and 4-segmented, palpal trochanter and patella without any setae. Palpal femur with one dorsal seta and palpal tibiotarsus with three basal setae and distal eupathidia.

The chaetotaxy of legs I-IV is as follows:

Trochanter	1-1-1-0,
Basifemur	2-2-2-2,
Telofemur	5-5-2-2,
Patella	4-4-3-3,
Tibia	7-7-5-5.

The chaetotaxy of tarsus is discussed in the text.

All segments of all legs bear pores. Trochanter III clavate and devoid of posterodorsal spine. Telofemorae III and IV devoid of ventral setae (Fig. 16, 17).Tibiae I and II bear one hair-like slender seta and two stout robust pectinate setae ventrally, besides 4 dorsal setae (Fig. 14, 15). Tibiae III and IV bear 3 ventral setae (two slender and one stout, robust with pecten) and two dorsal setae.

Tarsus I bears 3 dorsal long setae, 1 solenidion, distal to solenidion 1 profamulus, 3 ventral setae (one basal filiform seta and two distal singlet eupathidia) and 4 PAS (two doublet eupathidia). Tarsus II bears 3 dorsal long setae, 1 solenidion, 2 singlet eupathidia (PAS) and no ventral setae. Tarsus III bears 3 dorsal fossary setae, 1 proximodorsal seta and 2 PAS. Tarsus IV with 3 dorsal fossary setae and 2 PAS.

All legs with two lateral claws and a bidentate median claw. Lateral claws are smooth ventrally.

FEMALE: Idiosomal length of females ranged between 300 µm and 480 µm. Female closely resembles the male except for genitoanal region. The cuticular membranous areas present on the dorsal and ventral sides of female are broader than in male.The width of the cuticular membrane is variable in different specimens. Three PGS are present on each side of the GO (Fig. 12). GO is guarded by a pair of sclerites bearing one pair of SGS. Ovipositor is small.

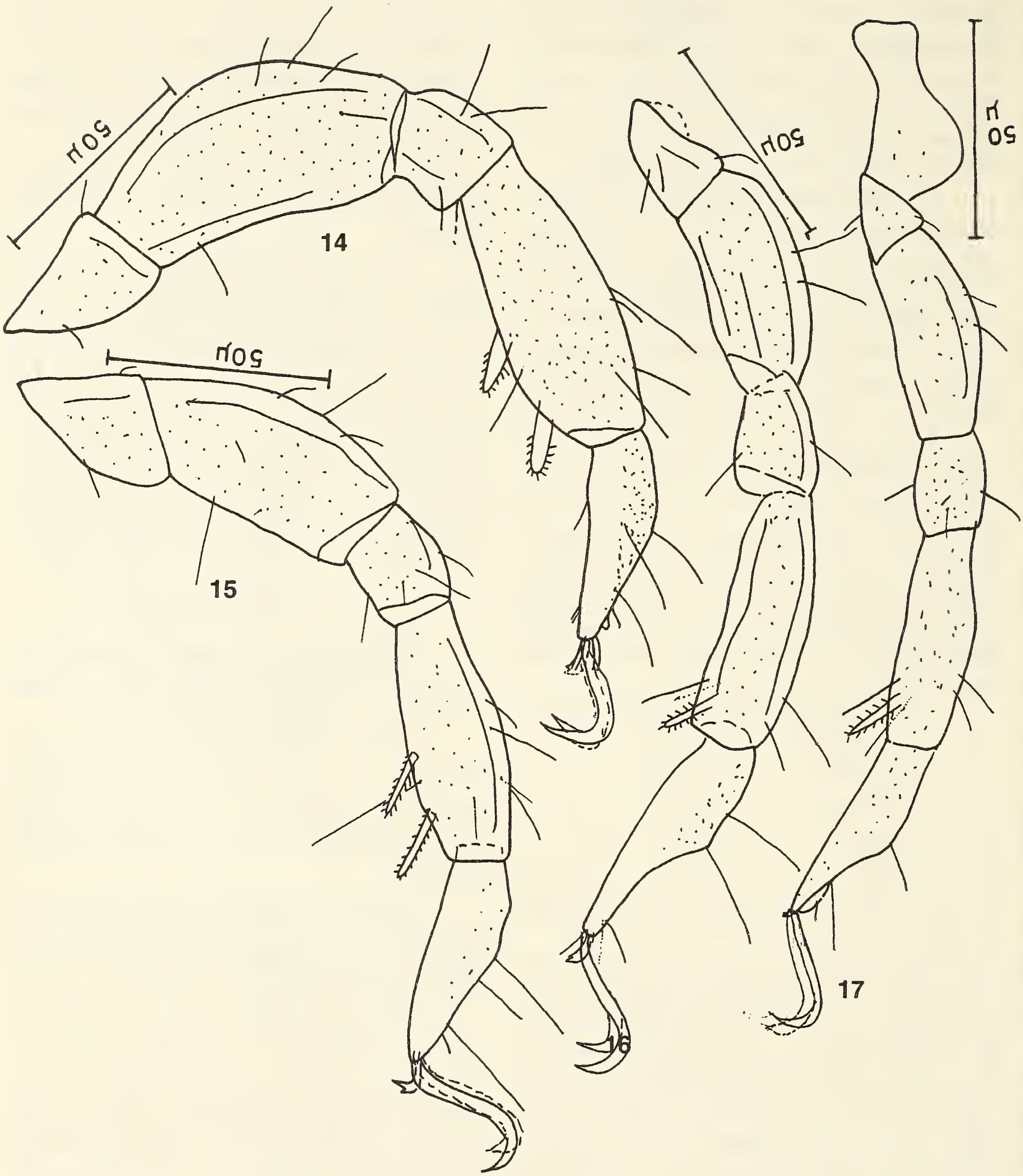
Discussion

The species can be aligned with Newell's key group 7700 (Newell 1984) as the specimen at hand has the following characters:

X, OC: OC, PD: PD, 1:1, Para (i.e. EP I absent, ds_2 on OC in both sexes, ds_3 on PD in both sexes, basirostral setae 1 pair in both male and female, striae between AD and PD parallel).

While the present species falls in with the key group 7700, it differs from all other species of that group in the following formula (developed following Newell 1984):

X, 2: Cir, nor, trion 4:3, X, 2:2, 8-10, 0:0. (i.e. X = neither pore nor swelling is present, 2 posterior areolae on AD circular to pear-shaped in outline, anal papilla in male normal in form, OC triangular, dorsal seta of leg III and IV with 4 and 3 respectively, X = no postgenital papilla present, SGS in male 2:2, PGS in male 8-10 pairs, ventral setae of telofemora III-IV are 0:0).



Figs.14-17: *Copidognathus balakrishnani* sp. nov.
14. leg I (Basifemur-tarsus); 15. leg II (Basifemur-tarsus); 16. leg III (Basifemur-tarsus); 17. leg IV.

The specimens under dicussion cannot be identified satisfactorily with any of the described species of the genus. The striking features like faint areolae on AD and 4 costae made up of porose panels, short and stout gnathosoma with a small rostrum and palp, tibiae I and II with 3 ventral setae (of which one is hair-like, slender, and the other two pectinate, robust), tarsi III and IV with 4:3 dorsal fossary setae render the specimens distinct and are treated as new to science.

ACKOWLEDGEMENTS

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MONELATA COMPLETUS, A NEW SPECIES OF DIAPRIIDAE (HYMENOPTERA : PROCTOTRUPOIDEA) FROM INDIA[1]

K. Rajmohana[2] and T.C. Narendran[3]

(*With four text-figures*)

Key words: New species, *Monelata completus*, Diapriidae, India

A new species of Diapriidae, namely *Monelata completus* is described from India.

Introduction

Proctotrupoidea represent one of the important superfamilies of parasitic Hymenoptera, but very little work has been done on the systematics of these insects. In the course of our investigation on the Proctotrupoidea of the Oriental Region (Rajmohana and Narendran 1996), we came across a new species of *Monelata* Foerster from Calicut, which is described below. At present only one species, *Monelata incisipennis* Huggert 1982, is known from India as well as from the Oriental Region.

Abbreviations used: AV - Anterior view; ABL - Length of Abdomen; ABW - Width of abdomen; DV - Dorsal view; F1-F11 - Flagellar segments; FWB - Forewing width; FWL - Forewing length; HL - Length of head; HB - Width of head; OD - Ocellar diameter; OOL - Ocellocular distance; POL - Postocellar length; TSS - Trans-scutal sulcus; TL - Length of thorax; TW - Width of thorax; T2 - Second abdominal tergite; DZCU - Department of Zoology, University of Calicut; ZSI - Zoological Survey of India, Calicut.

Monelata completus sp. nov. (Figs. 1-4)

Female: Length = 1.11 mm. Head black; thorax and abdomen deep blackish brown; propodeum and petiole pale brown; eyes black; wings hyaline; veins deep brown. Antennal pilosity and marginal fringe of wings brownish. Body pubescence and scales on petiole dull white.

Head (Figs. 1-4): HL:HB(DV) = 9:11; HL:HB (AV) = 12:11.2; viewed from above distinctly transverse, smooth, shiny, scattered erect pubescence, ocelli minute, on a slightly elevated area when viewed laterally; OOL:OD:POL = 8:2:3; occiput slightly emarginate; occipital flange narrow; gena not bulging but converging behind eyes to occiput; postgenal cushion distinct, with a lappet-like appearance; eyes globular, not bulging laterally, bare and located much anteriorly, sub-oval, slightly shorter than finely converging gena; viewed laterally higher than long; rather trapezoid, HH:HL = 13.5:12; face and frons very hairy; frontal shelf protruding, antennal insertion slightly above level of vertex; mandible bidentate; malar groove wanting; malar space almost half of shortest width of eye; antenna 13-segmented, last 4 segments graually enlarged, terminal club segment much enlarged, longer than 3 penultimate segments together, antenna clothed with fine hairs, subequal to length of F2; scape thinner basally and thicker medially; length to thickness ratio of antennal segments from scape to F2 as follows: 31.5:7.87, 12:6, 6.7:3.77, 3.5:3.76; F2 to F7 subequal; proportions of F8 to F11 being 4.2:5.8, 6.5:7.9, 6.6:8.1, 20.9:10.45.

Thorax (Figs. 1-2): TL:TB = 18:10; slightly narrower than head; cervix distinct, smooth, overgrown laterally and basally with thick tufts of hairs and semi-hyaline scales, giving an overall foamy appearance; pronotum visible as a band anterolateral to mesonotum, pronotal collar in a wide circular area; metanotum

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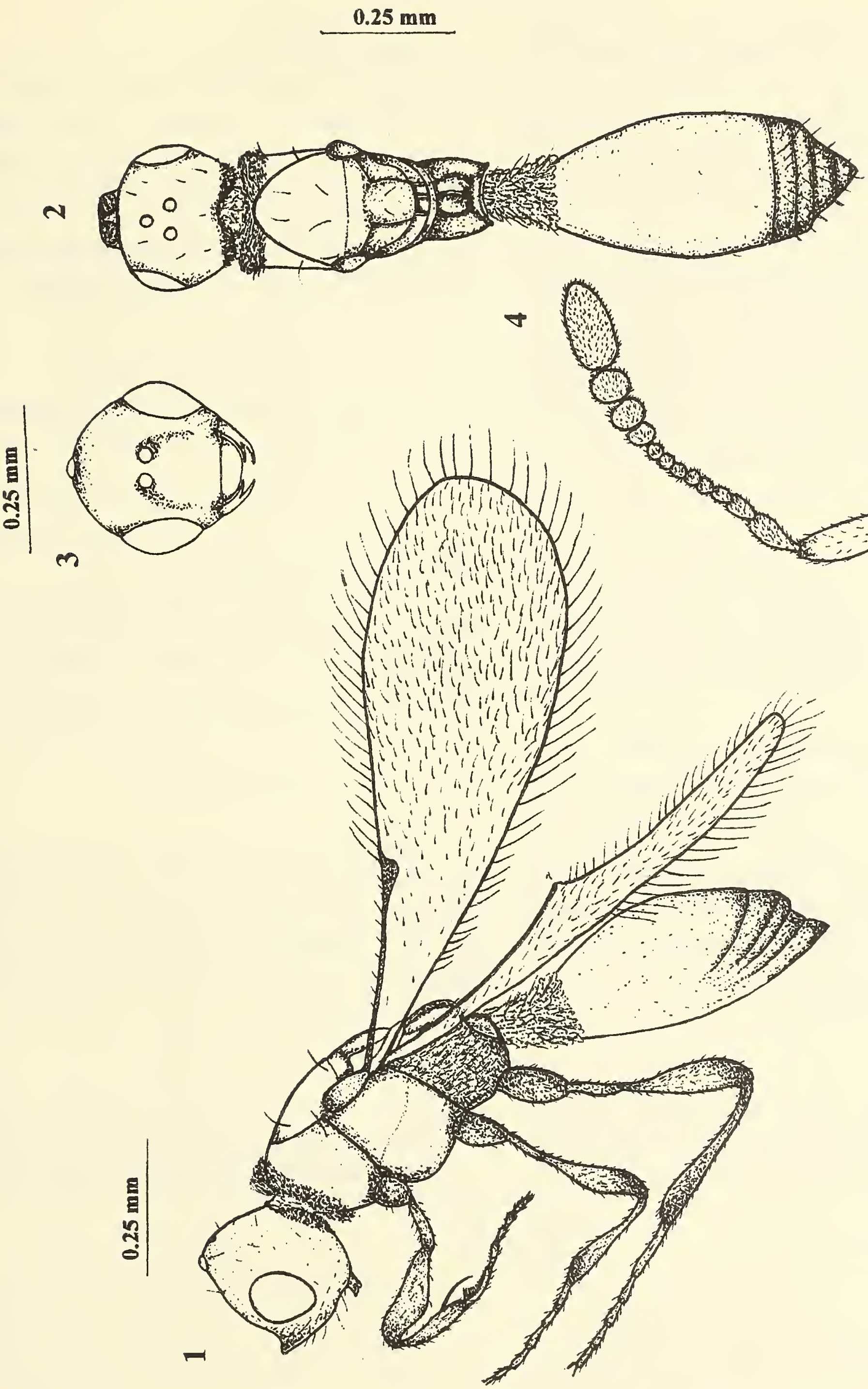

Figs: 1-4. *Monelata completus* sp. nov. (female)
1. Body profile; 2. Body dorsal view; 3. Head anterior view; 4. Antenna

smooth with two pairs of erect setae; notauli absent; TSS not very prominent; scutellum a rather broad zone, without any grooves or pits; gently arched with no median carina and basal fovea; shield wide with slightly convex lateral and posterior borders; metanotum with a reduced median and two lateral longitudinal keels; propodeum with a raised median longitudinal keel and with dorsal semi-hyaline zone and lesser raised two lateral ones; posterior border carinate; area between carinae and keel smooth and bare; propleuron and mesopleuron bare and smooth, with a faint impression of sternaulus; metapleural area covered with fine adpressed pubescence; legs normal, fore-tibia without an outwardly-directed spine; tibial spur formula 1.0.0; wings normal; forewing not longer than meso + metasoma combined and without an incised tip; FW L:B = 45:14.5; veins longer than 0.33 of length of wing, sm:total vein length = 7:16.5; distal portion of wing with rather long fringe, 0.33 of wing width; hind wing narrow, with fringe subequal to width of wing.

Abdomen: (Fig 1-2): ABL:ABW = 7.85:3.1 Petiole clothed with semi-hyaline, elongate scales, mixed with setae concealing posterior margin of petiole and basal margin of T2; petiole distinctly longer than broad; sub-parallel and abruptly narrowed to apex, T2 extending to 0.78 of abdomen (petiole + tergites); segments beneath T2 visible only as rings. T2:T3:T4:T5:T6 = 13.3:1:0.5:1:1.

Male: Unknown

Host: Unknown

Holotype: Female: INDIA. Kerala: Tiruvannur: 1.vi.1996, Coll. Mohana. (ZSI).

Paratypes: Two females, one with data same as holotype, the other also with same data except collection date being 16.x.1996. (DZCU).

Etymology: This species name is derived from a prominent character, namely forewing with the distal margin entire and not incised.

Discussion

This species differs from the only known Oriental species, *Monelata incisipennis*, in the following characters:

— Distal margin of forewing entire, without incision. (In *M. incisipennis* distal margin of forewing incised).

— Forewing not longer than meso + metasoma combined. (In *M. incisipennis* forewing longer than meso + metasoma combined).

— Proportions of antennal segments.

Acknowledgements

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A NEW SPECIES OF *PUNTIUS* (CYPRINIDAE : CYPRININAE) FROM MANIPUR, INDIA[1]

A.G.K. MENON, K. REMA DEVI[2] AND W. VISHWANATH[3]

(*With two plates*)

Key words: Cyprinidae, *Puntius manipurensis* sp.nov., *P. phutunio*, Manipur

Puntius manipurensis is described as a new cyprinid species of the genus *Puntius*, from Loktak lake, Manipur, India. It is characterised as follows: osseous, serrated principal spiny ray of dorsal fin, incomplete lateral line with 22-24 scales, 3.5 rows of scales in transverse series from the anteriormost portion of dorsal fin to lateral line, 3.5 rows between lateral line and pelvic insertion, without barbels, two spots on sides of body: a shoulder one on 3rd and 4th lateral line scales and a caudal one on 17th and 18th lateral line scales. The closest relative of *P. manipurensis* is *P. phutunio*. The affinities of these two species and other closely related species with a serrated dorsal fin ray, without barbels and with two spots on the lateral sides of the body, namely *ticto*, *punctatus* and *stoliczkanus* are discussed. A key to Indian *Puntius* species, including the new species with a strong osseous and serrated primary dorsal fin ray, is provided.

Cyprinid fishes of the genus *Puntius* are widely distributed in south and southeast Asia. The species of this genus have a single pair of maxillary barbels or none, normally 8 branched rays in dorsal fin, 30 or less vertebrae, scales thick with radii projecting from the focus to the margin like spokes on a wheel, without any posterior deflection in the lateral fields. *Puntius* species are small to tiny, less than 150 mm in total length. The *Puntius* from Manipur is very distinct from *phutunio* (Hora 1921, Menon 1954) which it was so far referred to, chiefly in its shape and colour markings, and also from all other *Puntius* species described previously (Day 1875-78, 1889; Jayaram 1991; Talwar and Jhingran 1991; Menon 1999), hence it is described here as a new species, *P. manipurensis*. The descriptions are based on eight specimens collected by Dr. W. Vishwanath from Loktak lake at Moirang, Manipur and deposited in the fish collections of the Zoological Survey of India, Chennai. Measurements follow standard practices (Menon 1987), except for pre-pectoral distance, which is taken as the distance from snout tip to pectoral insertion; the mean values for the specimens are given first, followed in parenthesis by range as percentage.

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Puntius manipurensis sp. nov.

(Plate 1, Figs. 1-3)

Holotype: F. (Fish) 4261, ZSI/SRS (Zoological Survey of India/Southern Regional Station), 40 mm Standard Length (SL), Loktak lake, Moirang, India, collected by W. Vishwanath, April, 1995.

Paratypes: F. 4262, ZSI/SRS, 7 specimens, 34-45 mm SL, data same as for holotype.

Diagnosis: A small elongate *Puntius* species with two spots on the body, a shoulder spot on 3rd and 4th lateral line scale rows and a caudal spot on 17th and 18th lateral line scales; scales edged dark; without barbels; ossified and denticulated dorsal spiny ray; incomplete lateral line with 24-25 scales and 3.5 scale rows between it and root of the pelvic fin.

Description: D. iii, 8; P. i. 13-14; V. i. 7, 1; A. iii, 5; C. 10+9. Body elongate, its depth 32.8 (29.7-35.1) percent of SL; head small, its

length 29.1 (27.5-30.0) and its maximum depth 22.5 (20.9-23.8) of SL; snout short, smaller than eye, 24.3 (22.9-25.8) of head length (HL), 66.3 (60.4-73.7) of interorbital width; eyes large, visible from ventral side, diameter 27.1 (25.2-30.0) of head, 73.9 (67.4-79.5) of interorbital width; mouth semicircular and inferior; barbels absent.

Dorsal fin origin closer to caudal fin base than to tip of snout, starting after 8th scale of lateral line, slightly behind origin of ventral, predorsal length 52.9 (51.5-53.7), postdorsal length 51.0 (47.8-58.7) of SL; margin of dorsal almost straight, principal spiny ray of dorsal fin osseous and denticulated, with flexible portion much shorter than head, its stiff portion a little more than postorbital part, dorsal fin height 21.3 (19.5-23.8) of SL, 72.2 (60.1-81.0) of HL. Pectoral fin pointed in profile, almost reaches pelvic fin, length 21.0 (19.2-23.8) of SL, 72.2 (64.8-80.0) of HL, pre-pectoral distance 28.9 (27.8-30.4) of SL. Pelvic fin pointed, reaches anal opening, length 20.4 (19.2-22.6) of SL, 70.3 (63.9-77.0) of HL, pre-pelvic distance 49.7 (47.6-51.7) of SL. Anal fin laid flat, falls 2 scale rows short of caudal fin base, its length 51.4 (44.5-55.8) of HL, preanal distance 71.2 (70.2-72.5) of SL. Caudal fin as long as length of head, deeply forked, its lobe pointed; caudal peduncle depth 68.1 (62.5-78.6) of its length, 13.5 (12.6-14.4) of SL, its length 19.9 (16.6-21.7) of SL. Maximum length of body cavity 44.1 (42.1-46.1) of SL. Gill rakers broad and low, 7 on the lower arm of the first gill arch and 3 on the upper arm.

Scales large; lateral line incomplete, pored scales ceasing by 5th or 6th scales; scales along lateral line 22-24; 3.5 rows in transverse series from dorsal fin origin to lateral line, 3.5 from lateral line to pelvic fin base; predorsal scales 8-9.

Colour in preserved specimens: Males darker, a spot on 3rd and 4th lateral line scales, prominent in paler specimens, another spot on the 17th and 18th lateral line scales; scales edged with pigments; two or three rows of spots on dorsal. Fresh specimens with yellowish fins; pelvic, anal and sides behind pectoral crimson. Maximum length: 45 mm SL.

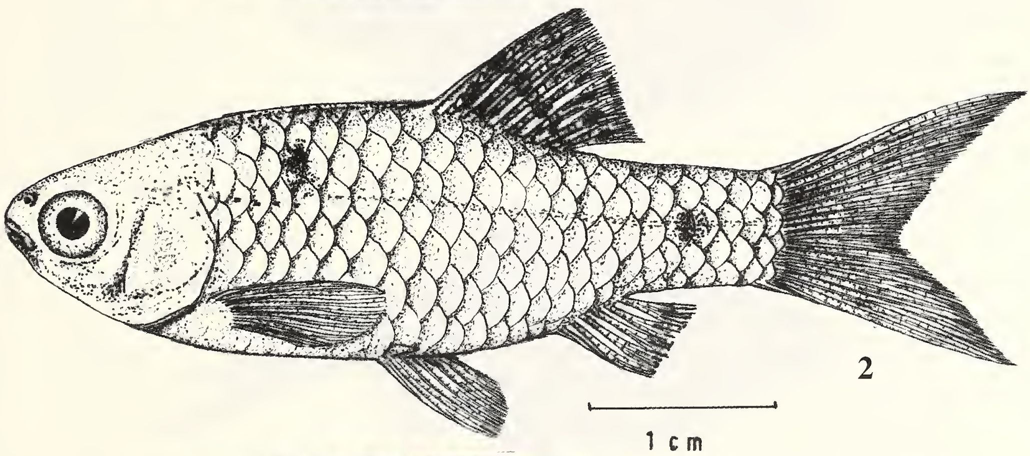
Distribution: INDIA: Manipur, Loktak lake.

Etymology: The new species is named after the collection locality.

Remarks: Geographically, the closest relative of *P. manipurensis* seems to be *P. phutunio* (Hamilton 1822), which is known from West Bengal and Bangladesh. Like *P. phutunio*, it has an incomplete lateral line with 3.5 rows of scales between the origin of dorsal fin and the lateral line, with 3.5 rows of scales between lateral line and pelvic fin base. There is, however, no similarity in colour and body form (Plate 2, Figs. 1 and 4), *P. manipurensis* having an elongate body. Hora (1921) mistook the species for *P. phutunio* and described its distribution as given in the field guide by Annandale (vide Hora, *op. cit.*). The colour of the living specimen, as observed by Annandale, is "The dorsal surface brownish, deeply tinged with metallic green and dotted with black, sides metallic crimson, each scale edged with black; ventral surface silvery; pelvic, anal and caudal fins crimson; dorsal and pectoral bright olivaceous green with the rays more or less infuscated and with black spots on the dorsal. Iris crimson, lower part of cheek and operculum silvery white, densely speckled with black". *P. phutunio* is characterised by vertical bands (Plate 2, Fig. 4). In its lateral transverse rows *P. manipurensis* resembles *P. stoliczkanus* (Day 1871) known from Burma and Thailand, and *P. punctatus* (Day 1865) known from the southwest tip of peninsular India and Sri Lanka, but differs from them in having an incomplete lateral line.

The new species belongs to the *ticto* group of fishes with which it shares the following characters: absence of barbels, presence of osseous and serrated principal spiny ray in dorsal fin and two spots on the body, a shoulder spot

1



2

3

Figs. 1-3: 1. Lateral view of *Puntius manipurensis* sp. nov., 40.0 mm SL, Holotype, F. 4261, ZSI/SRS;
2. Lateral view of *P. manipurensis*, 35.5 mm SL;
3. Lateral view of fresh specimen of *P. manipurensis,* 35.5 mm SL.

The authors and the BNHS are grateful to the Mehta Scientific Education and Research Trust, Mumbai, for sponsoring this colour plate.

Menon, A.G.K. *et al.*: *Puntius manipurensis* sp. nov. PLATE 2

Figs. 1-4: 1. Lateral view of *P. manipurensis*, 40.0 mm SL.;
2. Lateral view of *P. ticto*, 38.0 mm SL, F 2100, Minjur, Tamil Nadu.;
3. Lateral view of *P. punctatus*, 40.0 mm, SL, F 3466, Kottayam, Kerala;
4. Lateral view of *P. phutunio*, 24.0 mm SL, UMMZ 208868, Rangpur, Bangladesh.

The authors and the BNHS are grateful to the Mehta Scientific Education and Research Trust, Mumbai, for sponsoring this colour plate.

and a caudal spot. This species seems to have evolved in the Loktak lake from the same stock as *P. ticto* (4.5 rows of scales between lateral line and pelvic fin base) known to be widely distributed in India, *P. punctatus* in southern tip of peninsular India and Sri Lanka (Plate 2) and *P. stoliczkanus* (3.5 rows of scales between lateral line and pelvic fin base) in Burma and Thailand.

Key to the *Puntius* species with a strong, osseous and serrated primary dorsal fin ray

1. With 1 pair of maxillary barbels 2
— Without barbels 3
2. Body deep, 4 times in SL; no black spot above anterior anal base ..... *P. fraseri* Hora & Misra
— Body elongate, 5 times in SL; a black spot above anterior anal base .... *P. sharmai* Menon & Rema Devi
3. Lateral line (L1) scales 36 or more .... *P. ambassis* (Day)
— L1 scales less than 36 4
4. L1 scales more than 30 .... *P. guganio* (Ham.)
— L1 scales less than 30 5
5. Lateral transverse (L tr) scale rows 5.5/5.5 .. .. *P. conchonius* (Ham.)
— L tr rows fewer 6
6. L tr scale rows between L1 and pelvic fin base 4.5 .... *P. ticto* (Ham.)
— L tr scale rows between L1 and pelvic fin base less than 4.5 7
7. Lateral line complete 8
Lateral line incomplete 10
8. L1 scale rows 20 . *P. setnai* Chhapgar & Sane
— L1 scale rows more than 20 9
9. Two black spots on L1, one above 3rd scale and the 2nd a little before 19th L1 scale; dorsal fin not spotted .... *P. stoliczkanus* (Day)
— Two black spots on L1, one below commencement of L1 and the 2nd beyond 19th L1 scale; dorsal fin spotted in rows .... *P. punctatus* (Day)
10. L1 with 24 or more scales ... *P. gelius* (Ham.)
— L1 with less than 24 scales 11
11. A horizontal line on sides of body and two distinct dark blotches on caudal peduncle .... *P. shalynius* Yazdani & Talukdar
— No horizontal line on body or paired blotch on caudal peduncle 12
12. Body deep and banded; dorsal without spots, but with a band .... *P. phutunio* (Ham.)
— Body slender, not banded. but with two spots; dorsal with rows of spots .... *P. manipurensis* sp. nov.

Comparative material *P. phutunio*: University of Michigan Museum of Zoology (UMMZ) 208868, 24 mm SL, Rangpur, Dharia river, Bangladesh, 2.iv.1978, coll. W. Rainboth & A. Rahman.

Acknowledgement

We are grateful to the Director, Zoological Survey of India and Officer-in-Charge, Southern Regional Station, ZSI for facilities.

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■ ■ ■

REVIEWS

1. THE TIGER IS A GENTLEMAN by Vivek Sinha, Published by Wildlife, Bangalore, 1999. Pp. 160, (23 x 18 cm). Hardbound price Rs. 395/-

For several years now, any high quality wildlife photograph published in journals and books in India is likely to be the work of Vivek Sinha, retired bureaucrat, aeronautics engineer and wildlife photographer *par excellence*. The husband and wife team of Vivek and Arati Sinha are committed conservationists, whose photographs speak eloquently of India's wildlife.

In this slim volume, Sinha writes of the unforeseen encounters he has had with wildlife during his camera hunts. How it feels being charged by an angry tiger settling in new territory, the unlooked for suspense when their jeep breaks down amongst elephants, and similar encounters where only the forbearance of wild animals brought a happy ending. There are 15 chapters all superbly illustrated with Sinha's photographs.

The book is beautifully produced and worthy of its subject — the wildlife of India.

■ J.C. DANIEL

2. THE DANCE OF THE SARUS: ESSAYS OF A WANDERING NATURALIST, by S. Theodore Baskaran, Published by Oxford University Press, New Delhi, 1999. Pp. xviii+240, (21.5 x 14 cm). Hardbound price Rs. 295/-

There are very few Indian bureaucrats who utilize their time and opportunity in a meaningful way. Mr. S. Theodore Baskaran, a retired high official of the Indian Postal Service, is one of them. All his extra time was devoted to the study of natural history and he utilized the opportunity of his postings to different parts of the country to visit the natural areas. For the last 30 years, he has delighted readers of the highly respected *Hindu* newspaper by his eminently readable articles and filled the void left by M. Krishnan, another wonderful raconteur of nature, who would make even mundane observations on a house sparrow or a sambar into a masterpiece of natural history anecdotal writing.

The book contains 53 highly readable short essays, previously published in the *Hindu*, *Swagat*, *Frontline* and *Down to Earth*. Wherever required, the information is updated. For example, the article "Their well-being is a litmus test" was first published in the *Hindu* in 1982. In this book, it is published as "Driver to Extinction", but the information on the discovery of Jerdon's courser in 1986 and forest spotted owlet in 1997 has been added as a footnote.

Mr. Baskaran is really a wandering naturalist, as the subtitle of the book says. He has travelled all over the country, watching Ceylon frogmouth in Indira Gandhi Wildlife Sanctuary in Tamil Nadu and the dipper in the Himalayas, sarus crane in Gujarat and leaf monkeys in Tripura. Twenty-three articles are on birds, 10 on mammals, 9 on habitats, 8 on conservation issues and 3 on domestic animals. One of the most interesting and informative articles is on the donkeys of the world. It is not a treatise on these much-maligned animals, but still it is full of new information. Despite the fact that human beings use millions of donkeys for various chores all over the world, only Kenya has recognised their value and has printed a postage stamp in their honour. Mr. Baskaran should know, because he served in the Indian Postal Service for almost 35 years.

The book is not without blemishes. I do not know from where Mr. Baskaran got the information that 7,456 great Indian bustard are left 'in the whole country' (article first published in the *Hindu* on April 12, 1988). At that time, the total number could be between 1,500 and

now sadly it is less than 1,000. Mr. Baskaran has also made the common mistake, (or was it the editor's (?), of writing 'blackbuck' the English name for *Antilope cervicapra* or Indian antelope, as two words — black buck. Proper nouns are sometimes written in lower case, e.g. Eastern ghats, and 'society' for the Bombay Natural History Society. If we overlook such small mistakes, THE DANCE OF THE SARUS makes a good companion to those interested in light reading on Indian natural history.

■ ASAD R. RAHMANI

3. THE SERPENT'S TONGUE by Indraneil Das, Published by Edition Chimaira, Frankfurt, 1998. Pp. 121, (21.5 x 14 cm). Price not mentioned.

In THE SERPENT'S TONGUE, Indraneil Das, the most versatile and prolific among present day herpetologists, looks at the vernacular names of the reptiles and amphibians of the Indian subcontinent and adjacent countries. 1,738 vernacular names, 88 of amphibians and 1,650 of reptiles, from 70 languages have been listed. As the author says, knowledge of the vernacular names may give clues to behaviour, status, morphology, season of occurrence, habitat and some may be onomatopoeic, all of which are useful for the field biologist. Many of the generic and species names are derived from vernacular names and it is interesting to know the origin of such names. The absence of diacritical markings makes the correct pronunciation of the names difficult, compounded by the fact that English is not exactly an useful language for phonetic interpretation of other languages. What is now required is for Indian scientists to write back to the author the correct meaning of the names given in their mother tongue wherever there is an error, and try and spell out the names in tune with their pronunciation. The ideal solution would be to have a CD-Rom where the names are pronounced by a person skilled in a particular language. The book with its indices is a very commendable and useful effort indeed.

■ J.C. DANIEL

4. THE FAUNA OF BANGALORE by S. Karthikeyan. Published by World Wild Fund for Nature, Bangalore, 1999. Pp. 48 + vi plates, (21 x 13.5 cm), Price not mentioned.

The booklet is a compilation of data from various sources. The checklist is the first of its kind, as it lists all the major faunal groups — Mammals, Birds, Reptiles, Amphibians, Fishes and Butterflies recorded so far from Bangalore city and its surroundings. The content of this booklet is very basic and the author makes it clear that its purpose is to assist amateurs.

Some major changes in nomenclature have been omitted. For example, *Rana limnocharis* (p. 33) has been changed to *Limnonectes limnocharis*, *Riopa punctata* (p. 30) is now *Lygosoma punctatus*. Such mistakes could have been avoided if recent literature had been referred to. These, along with a few spelling mistakes, eg. *Macropodius* instead of *Macropodus* or *Bungarus caerulescens* (p. 31) instead of *B. caereleus* are some of the flaws in this small booklet, which otherwise is a good effort by the author to create conservation awareness in an urban area.

■ MEGHANA GAVAND

MISCELLANEOUS NOTES

1. DISTRIBUTION OF CHITAL *AXIS AXIS* (ERXLEBEN 1777) IN BUENOS AIRES PROVINCE, ARGENTINA

(*With one text-figure*)

Chital (*Axis axis*) was first introduced in Argentina for sport hunting in 1928 and 1930 in Magdalena, Buenos Aires province (Navas 1987). The species became well established in the country, and there have been records from Formosa, La Pampa, Neuquen, Cordoba, Santa Fe, Rio Negro, Entre Rios, Tucuman and San Luis provinces (Chebez 1994). The range expansion of chital has been assisted by translocation to new areas, mainly as a result of commercial interest from game ranches. Buenos Aires province manages chital as a big game species, and also permits shooting to control populations.

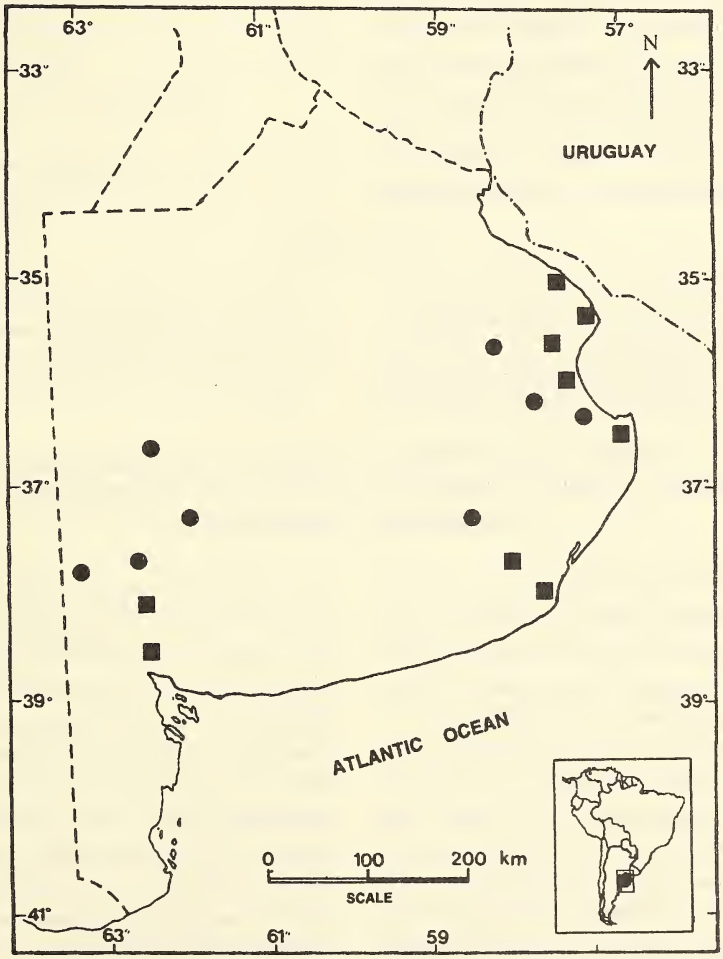

Fig. 1: Distribution of chital (*Axis axis* Erxleben 1777) in Buenos Aires Province, Argentina, South America. ■ Previous records (Navas 1987; Galliari *et al.* 1991) ● New records

From 1995 to 1997, we completed some field surveys to determine the ranges of introduced ungulates. We also compiled all literature and unpublished information from the local Wildlife Department to determine the past and current distribution and status of *Axis axis* and other exotic ungulates in Buenos Aires province.

In the study area, the species distribution is closely associated with *Celtis tala* forests (Rio de La Plata estuarine area), and with the two mountain chains (Tandilia and Ventania systems) in the province.

We confirmed chital occurrence in Magdalena, Chascomus, Castelli, Tornquist, Bahia Blanca, Gral, Lavalle and Berisso (Galliari *et al.* 1991) and also in General Pueyrredon and Balcarce departments (Navas 1987). Additionally, there have been new records for the species at General Belgrano, General Madariaga, Tordillo, Tandil, Coronel Suarez, Guamini and Dolores (Fig. 1).

It is necessary to delineate distribution to study the biology and assess the impact of chital on local flora, particularly the indigenous *tala* (*Celtis tala*) forests and pampas grasslands.

July 27, 1999

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2. TAKIN *BUDORCAS TAXICOLOR* AT MENLA RESERVE FOREST (3,050 M), EAST SIKKIM: A WESTWARD RANGE EXTENSION AND OBSERVATIONS OF UNUSUAL BEHAVIOUR

The Mishmi takin *Budorcas taxicolor* Hodgson was finally sighted in Sikkim in June 1999. For decades there were rumours of a solitary, large mammal locally called 'Tarkin' by the Lachungpa tribals of north Sikkim.

In recent times, the animal was first reported from Lema (*c.* 2,400 m) in Lachung, north Sikkim in September 1976. In May-June 1984, a villager Mr. Jorgay Lachungpa told me that an animal called 'Tarkin' occasionally comes across the Tembawa ridge adjoining Dombang valley, probably from the Chumbi valley to the Shingba Rhododendron Sanctuary area (*c.* 3,400 m), north Sikkim.

During the All India Tiger Census, December 1993, conducted by Mr. C. Lachungpa Divisional Forest Officer (Wildlife) of the Department of Forests, Environment and Wildlife, he sighted a large herbivorous animal from afar in a dense area of Menmoitso Reserve Forest (*c.* 2,500 m) in east Sikkim. His photograph, taken with a normal lens, showed vaguely a large animal like a bear or yak, but due to the distance it was not possible to identify it. It was suspected to be either a gaur *Bos gaurus* or Sikkim stag (Shou) *Cervus elaphus wallichi* Cuvier, possibly strayed over from Bhutan or the Chumbi valley. In July 1998, there was an

unconfirmed report from Khedum village (*c.* 2,000 m), in Lachung valley of a similar animal.

On June 13, 1999, Mr. Bishnu Kumar Sharma, a daily wager of Kyongnosla Alpine Sanctuary, east Sikkim on information from local people, had a glimpse of an unfamiliar large mammal at the 15 Mile Police Checkpost, Kyongnosla (*c.* 3,000 m) beside the Rongchu river. The animal was *c.* 250 m from the river near the department's plant nursery belonging to the Environment and Pollution Control (EPC) division. Due to dense fog, he could not see the animal clearly. The next day, local people saw the animal return to the area at around 1650 hrs. It came near the bridge, but returned towards the nursery.

On June 15, 1999, at *c.* 1300 hrs, this animal came once again to the same area and was seen grazing for nearly 40 minutes. Then it actually crossed the river through the surging water and came towards the road. Apprehensively, Bishnu approached almost 15-20 m close to the unfamiliar animal, but could not identify it. It went back by the same trail. Bishnu returned and sent a wireless message to Gangtok.

On June 16, 1999, Mr. C. Lachungpa reached the site at around 0600 hrs. He identified the site as part of Menla Reserve Forest, which is contiguous with Menmoitso forest further east, extending to the Pangolakha range separating Sikkim from Bhutan. At around 1230 hrs, he could go close enough to the animal to take photographs. He had with him Prater's 'THE BOOK OF INDIAN ANIMALS' and immediately identified it as an adult male Mishmi takin *Budorcas taxicolor*, its description matching perfectly with the 'golden-yellow colour merging into dark brown or black on the flanks and quarters'. The animal was unusually well built and seemed to be interested in a herd of domestic cattle further down the road. He watched it rubbing its horns against a *Rhododendron* bush, nearly uprooting it. It then turned to climb up to the base of an *Abies densa*, and slept under the tree in full view of the crowd of onlookers for two hours.

On waking and sensing human presence it wandered away, grazing and browsing on nearby bushes, sometimes going out of view. As Mr. Lachungpa and Bishnu changed positions and hid themselves, the takin appeared again on the trail, halted after 4-5 steps, turned to the slushy area near the riverbed and tried to cross the stream further down from the earlier spot. The takin then came to a freshly eroded debris slide and walked up it before seeing the two men. It then climbed up to the bushes and watched aggressively before resuming grazing. Mr. Lachungpa and Bishnu took more photographs.

The weather changed to a cloudy drizzle and the takin was last seen walking into the forest towards a ridge at around 1500 hrs. The local people, police and army personnel were told to watch its movements. On the night of June 19, 1999, the takin finally crossed over and headed up along the western flank of the Kyongnosla Alpine Sanctuary. On June 22, it was reportedly seen going further north towards Lagyap forest, presumably towards its old haunts near Lachung.

However, in less than a week, the migrant graziers began reporting harassment by the takin. It had taken to wandering around the three small livestock camps, attempting to mate with the cows and female yaks (called 'chaunri') and scaring away their horses. Three wildlife staff of Kyongnosla Alpine Sanctuary, Kalusingh Rai, Jeevan Rai and M.B. Pradhan, had begun patrolling the area to keep track of its movements. On July 23, 1999, they suddenly came upon the takin which promptly charged at them and chased them up a rhododendron branch and on to a big 'saur' (*Betula* sp.) tree. The takin remained at the foot of the tree for some time before moving off.

On August 5, 1999, I visited the area in connection with a study of grazing patterns in the sanctuary along with the three staff and driver Ramesh Tamang. We went up the old helipad

road for about 4 km before stopping off to visit the first *goth* or livestock camp. There we saw a pregnant cow with both forelimbs sprained or broken, caused by the takin's attempted mating. She was unable even to stand.

Climbing up towards the temporary shed of the second *goth*, we were alerted by shouts behind us. The takin against the skyline less than 100 m away was slowly and unhurriedly lumbering down towards us. Due to the earlier encounter, our staff was in favour of running away when the animal reached a close 30 m, separated from us only by a small stream. The takin, however, walked down its daily route towards the *goth* and its indignant owner standing outside waving his arms. The animal stood watching him for a few moments before crossing the stream to our side and moving away further downwards.

Nothing seemed to really disturb the animal and it was unnatural to see that the takin had no fear at all of man. Two days later, on August 7, 1999, the takin gored to death the shepherd of the third *goth*. His grandson, who escaped, ran to inform the checkpost police and our staff. They returned to see the body and shreds of clothing in the surrounding rhododendron bushes. The grandson informed us that the old man had been poaching monal and blood pheasants in the sanctuary and harassing the takin, which had attached itself to his flock of sheep. That day they had suddenly encountered the animal, only to be charged by it, and being the younger of the two, the grandson had managed to run away.

This is the first time that the old reports could be verified and with photographic proof. The takin, which is protected in India under Schedule I of the Wildlife (Protection) Act 1972, as amended up to 1993, does occur in Sikkim. As of now, all the three goat-antelopes in India, i.e. the goral, serow and takin can be said to be found in Sikkim.

Perhaps separated from its herd, this is the same solitary takin isolated on this side of the Chola Range that has been sighted over the years. In fact, the forests ran almost contiguous to north Sikkim along the entire flank of the famed Chumbi Valley (now in Tibet) starting from the Chola range which forms the eastern boundary of Sikkim. This is also the route used by the tiger *Panthera tigris* to travel up to Lachung and Yumthang in north Sikkim up to five decades ago and as recently as November 29, 1998, when an adult male tiger's pugmarks were lifted from the same Lagyap Reserve Forest above Gangtok by Mr. C. Lachungpa. Hence, this sighting of the takin in Sikkim proves a definite westward extension of its range, adding yet another endangered species to the already threatened faunal diversity of Sikkim.

Acknowledgements

I thank the Department of Forests, Environment & Wildlife, Govt. of Sikkim, including the Chief Wildlife Warden, the Sanctuary staff and driver Ramesh Tamang for enabling this record.

July 13, 1999

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3. FIRST RECORD OF OCCURRENCE OF ALBINO CRESTLESS HIMALAYAN PORCUPINE *HYSTRIX BRACHYURA* LINNAEUS, 1758 (RODENTIA : HYSTRICIDAE) IN INDIA

While examining the skins of porcupines [Indian crested porcupine *Hystrix indica* Kerr, 1792; crestless Himalayan porcupine *Hystrix brachyura* Linnaeus, 1758; brush-tailed

porcupine *Atherurus macrourus* (Linnaeus 1758)] present in the National Zoological Collection of the Zoological Survey of India, Calcutta, we came across an albino specimen of the crestless Himalayan porcupine *Hystrix brachyura* collected from Manipur, India. The literature has no record of albinism in *Hystrix brachyura* in India.

All measurements, external and cranial, are in millimetres.

Material examined: INDIA: Manipur: Imphal district: 1 ♀ subadult: 28 km north of Imphal on Dimapur Road, 29.xi.1945, coll. M.L. Roonwal. Rolled skin, Regn No. 11349, Mammal and Osteology Section, Zoological Survey of India, Calcutta.

Measurements: Female. Subadult. External: head and body 555.0, tail 120.0, hindfoot 85.0, ear 37.0, Cranial: occipitonasal 119.0, nasal 66.2, palatal length 55.0, length of bulla 17.2, zygomatic width 64.3, diastemma 32.0, length of mandible 75.5.

Diagnostic Character: Absence of crest of bristles on the crown, tail not brush-like. The specimen is albino i.e. without any pigmentation.

Distribution: INDIA: Sikkim, Assam, Nagaland, Manipur (Roonwal 1950). Nepal, Bangladesh, central and southern China, Myanmar, Thailand, Indochina, Malaya, Sumatra, Borneo, Singapore, Penang and Hainan Is. (Corbet and Hill 1992, Wilson and Reeder 1993).

September 15, 1999

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4. FIRST RECORD OF GANGETIC RIVER DOLPHIN, *PLATANISTA GANGETICA* AT POBITORA WILDLIFE SANCTUARY, ASSAM

The Gangetic river dolphin, *Platanista gangetica*, locally known as *sihu*, is a native of the Ganga and Brahmaputra river systems. On August 8, 1998, while on inspection duty, I sighted a juvenile Gangetic dolphin at Garanga *beel* on the southwest boundary of Pobitora Wildlife Sanctuary. This rare and endangered animal was observed plunging up and down in the water for about an hour, maneuvering in an area of around 100 sq. m. The dolphin was grey and approximately 90-100 cm long.

The dolphin was sighted about 2-3 km away from River Brahmaputra and hardly 220 m from River Kolong, a tributary of Brahmaputra. During the sighting period, the Sanctuary was submerged in flood waters, up to 3.5-9.5 m from normal ground level. The flood water remains in the Sanctuary for almost three months i.e. from June to August.

The dolphin was last sighted further downstream on August 17, 1998. After observing the single animal for almost 10 days, it was concluded that the Gangetic dolphin occasionally migrates to high flood areas during the monsoon.

This is the first record of dolphin in the *beels* of Pobitora Wildlife Sanctuary.

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5. A PIED HARRIER (*CIRCUS MELANOLEUCOS*) ROOST IN SOHAGI-BARWA WILDLIFE SANCTUARY, MAHARAJGANJ, UTTAR PRADESH, INDIA

On March 23, 1998 while surveying the grasslands of Sohagi-Barwa Wildlife Sanctuary (27° 10' to 27° 20' N & 83° 35' to 83° 50' E) in Uttar Pradesh, I came across a roost of pied harrier *Circus melanoleucos*, in what was possibly the largest number ever reported from India.

As I was moving through the Nagwa grasslands I saw two male pied harriers on the ground, about 50 m from Mankapur-Madhualia road. It was 1730 hrs when I saw the first two birds and as I stopped to scan the area more birds descended on the same patch. I counted 20 birds, 3 females and 17 males. The birds I saw were mostly close to the road, in patches where the grass had been cut, and those which landed while I was scanning the area. Although the grass had been cut, it was tall enough to hide these birds, and I suspect the harrier numbers to be much higher, probably around 50 birds.

The grasslands of Mankapur Beat in Nagwa Compartment 16 (Madhualia Range) are among the largest blocks of grasslands in the entire Sohagi-Barwa Sanctuary and are in continuation with the Ghanshyampur grasslands of South Chowk Range.

The pied harrier is a winter visitor to the eastern parts of the Indian subcontinent, quite common in Bangladesh, Pakistan, Manipur, Assam (where it occasionally breeds), West Bengal, Bihar, Orissa and decreasingly so down the eastern side of the Peninsula and in small numbers to Sri Lanka, occasionally in Kerala, Nilgiri and Palni Hills in Tamil Nadu (Handbook, Ali and Ripley 1987). It has been reported from eastern districts (Balghat and Bhandara) and northwest Madhya Pradesh (Rahmani 1988). Vyas (1992) has reported this species from southeast Rajasthan. Rare stragglers or vagrants have been seen in Andhra Pradesh and Maharashtra. It is not recorded north of Bombay in western India, and west of the Nepal terai and Gorakhpur district in Uttar Pradesh. In Dudwa National Park, Uttar Pradesh, a few birds have been seen regularly in the Madrayya region in the last few years and near Dudwa at Kishanpur, Katerniaghat and Pilibhit region.

These birds affect open grass patches, hills (to *c.* 2,100 m – Kodaikanal), paddy fields, stubbles and grassy margins of *jheels* (natural water bodies). Though mainly extralimital in breeding, they occasionally breed in Assam (Dibrugarh district – Kaziranga). Narayan and Lima (1991) have reported breeding of pied harriers in Manas Wildlife Sanctuary and suspect at least three breeding pairs. They also believe that a few of these birds breed regularly in the alluvial grasslands south of the Himalayas and north of the Brahmaputra in lower Assam, and possibly on islands and the southern bank of the river in Laokhowa Wildlife Sanctuary, Burachapuri and Kochmara reserves, Kaziranga National Park and Majuli Is.

The pied harrier roost in Sohagi-Barwa Wildlife Sanctuary is important on three counts. First, it is the largest reported in India, secondly it is further west of the reported range in Assam, and thirdly the roost was found in a disturbed grassland where grazing and grass cutting was frequent. As pied harriers are an important species of these alluvial grasslands, it is essential to give high priority to the protection of these grasslands. To protect pied harriers and other such typical grassland fauna, grazing and cutting should be checked.

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6. THE GREYHEADED LAPWING, *VANELLUS CINEREUS* (BLYTH) IN KALIVELI TANK, TAMIL NADU

On January 25, 1997, I was surveying water birds in Kaliveli Tank, a brackish wetland on the east coast in Tamil Nadu (12° 05'-12° 15' N, 79° 47'-79° 59' E). In the midst of two curlews, *Numenius arquata,* and five large egrets, *Ardea alba,* there was a grey headed wading bird which struck me as unusual. I approached closer, wading into the slush and watched with my binoculars at a distance of about 20 m. It was a greyheaded lapwing, *Vanellus cinereus* (Blyth). I watched the bird feeding for two minutes and edged closer, whereupon it took off and settled about 100 m away. I watched it for some time and then tried to see if there were other individuals of the species. It was a lone bird, and after half an hour, flew away silently. The bird was distinguished from other lapwings by the completely smoke-grey head and neck; yellow beak and wattle. The primaries were black and the tail feathers had a broad black subterminal band. In flight, the bird spread out its tail feathers. It was a juvenile, as the dark pectoral band of the adults was missing (Ali and Ripley 1980).

This species is known to be a regular winter visitor, from September-October to March-April, to India in Assam, Manipur, North Bihar, Dehra Dun, Rajasthan and the Andaman Islands, as well as several places in 'East India' (Ali and Ripley 1980). Subramanya (1987) has recorded this species from Bangalore. This sighting is the second record for the species in peninsular India. The bird was probably a vagrant, since I had not seen it during my survey of the region in 1995-96, nor did I record it in 1998. Perennou (1987) and Perennou and Santharam (1990) have conducted detailed ornithological surveys in this region and have not come across this species.

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7. RECENT SIGHTINGS OF *VANELLUS GREGARIUS* (PALLAS) AT TAL CHHAPAR AND REVASA, RAJASTHAN

The migratory lapwing *Vanellus gregarius* breeds semi-colonially, chiefly in transition zones between *Stipa* and *Artemisia* steppes, in Russia and Kazakhstan (Collar *et al.* 1994). It winters in Sudan, Eritrea, Israel, Arabian Peninsula, Iraq, Pakistan and northwest India. Though it is described as regular and fairly common in Pakistan and northwest India in the HANDBOOK (Ali and Ripley 1980), Roberts (1991) calls it rare in Pakistan. According to del Hoyo *et al.* (1996), it is vulnerable and numbers wintering in the Indian subcontinent probably do not exceed 1000.

The lack of recent authentic sightings indicates that it is rare in Rajasthan. Although it is not recorded in the vertebrate fauna of Keoladeo National Park, Bharatpur (Vijayan *et al.* 1987), all the recent sightings in Rajasthan are from the Park, Bharatpur where its numbers vary greatly, even being absent in certain years (Per Undeland *pers. comm.*) It seems safe to assume, therefore, that it visits Bharatpur sporadically.

Five birds were seen foraging on October 14, 1995 at Tal Chhapar Sanctuary, Churu, Rajasthan. The birds were exceptionally obliging and allowed us a close approach.

The second sighting of *Vanellus gregarius* at Tal Chhapar was on a cold and windy morning on January 28, 1998. After what initially seemed a hopeless task, we were able to discover a flock of 15 resting birds. All the birds were well concealed in the hoof prints of an unidentified mammal and were reluctant to move out in the inclement weather.

A flock of 11 birds were seen foraging at Tal Chhapar on February 1, 1998. Unfortunately, some villagers disturbed the flock and it took off, uttering a weak call, best transcribed as *reck-reck-reck.*

During these three sightings at Tal Chhapar, the ground was dry and hard with short grass that was almost dry. Other species noticed in the area were the short-toed lark *Calandrella cinerea*, eastern calandra lark *Melanocorypha bimaculata*, and tawny pipit *Anthus campestris*.

A juvenile *Vanellus gregarius* was recorded on January 31, 1998 at Revasa, Sikar, Rajasthan. The bird was feeding on an undulating grassland in the midst of mustard fields. The ground was sandy and soft, with traces of salt at some places, due to waterlogging. Normal human activity was noticed in the area, a shepherdess was tending her flock, tractors and jeeps drove down the road passing through the grassland. Unlike the flock seen at Tal Chhapar on February 1, 1998, the bird was not wary. Other species noticed in the patch were redwattled lapwing *Vanellus indicus*, common sandgrouse *Pterocles exustus*, eastern calandra lark *Melanocorypha bimaculata*, crested lark *Galerida cristata* and desert wheatear *Oenanthe deserti*.

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8. ADDITIONAL SIGHT RECORDS OF SLENDERBILLED GULL *LARUS GENEI* FROM GUJARAT

The slenderbilled gull *Larus genei* Breme is considered to be a winter visitor to the west coast, west to Sindh, Gujarat and Bombay (Ali and Ripley 1983). Except for one specimen collected by Dharmakumarsinhji (1955) near Bhavnagar, the species was not recorded either from Kachchh (Palin and Lester 1904, Ali 1945) or from mainland Gujarat. However, Mundkur *et al.* (1988) have reported sighting of the species from several locations around the Gulf of Kachchh and opined that it is a common winter visitor there.

We too have seen this species at several places in fairly good numbers around the Gulf of Kachchh (Table 1). We have also recorded it repeatedly from Porbander (east coast of Saurashtra) and Bhavnagar (Gulf of Khambat), suggesting that it is common on the Gujarat coast in general. This supports the views of Mundkur *et al.* (1988).

TABLE 1
RECORDS OF SLENDERBILLED GULL FROM GUJARAT COAST

S. No.	Site	No. of birds	Date
1.	Narayan Sarovar	50	26.ix.1992
2.	Jakhau	5000	25.ix.1992
3.	Surajbari	4	4.x.1991
4.	Pirotan Island	A few	8.iii.1980
5.	Charakla Salt Pans	129	28.xii.1996
6.	Okha	2	28.xii.1996
7.	Harshad Dam	2	30.xii.1996
8.	Porbander Bird Sanctuary	3	2.iv.1996
9.	Porbander Bird Sanctuary	6	31.xii.1996
10.	Porbander Salt Pans	6	27.iv.1997
11.	Porbander Salt Pans	36	15.vi.1997
12.	Bhavnagar Port	2	31.xii.1995

At Jakhau, the slenderbilled gull along with the lesser blackbacked gull *Larus fuscus* and herring gull *Larus argentatus* was seen resting and occasionally feeding on the fishes drying on the ground. At Narayan Sarovar, the birds were seen flying above the creek. At Charakla salt pans, they were swimming along with blacknecked grebes *Podiceps nigricollis*. At Porbander, the birds were seen both in the sanctuary area and salt pans. Records of this gull during April and June at Porbander also support the view of Mundkur *et al.* (1988) that it may be nesting within our limits, or that the non-

breeding individuals tend to stay over within our limits.

The available data and our own intensive studies on the coast of Gujarat suggest that the gull is quite abundant on the Gulf of Kachchh, but not so on the Gulf of Khambat. One of us (Parasharya 1984) studied the coastal avifauna near Bhavnagar and Ghogha during 1979 to 1983, but had seen it only once. It is possible that the species was overlooked because of its similarities with the blackheaded gull *Larus ridibundus* in winter plumage (Ali and Ripley 1983, Mundkur *et al.* 1988). Hence, a careful survey of the Gulf of Khambat might yield a few more sightings.

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9. MULTIPLE BROODING OF THE LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS*

An instance of multiple brooding by a pair of little brown doves, *Streptopelia senegalensis* Linn. and their incubation rhythm was observed in Bharatpur, Rajasthan, India in 1987-1988. Though multiple brooding is reported in most of the columbids (Westmoreland *et al.* 1986) including *Streptopelia senegalensis* (Ali and Ripley 1983), frequent and continuous brooding by *Streptopelia senegalensis* is so far not reported. The little brown dove reportedly raises two or more broods (Ali and Ripley 1983).

Columbids produce food (crop milk) for the young nestlings *in vivo* and feed older nestlings a diverse diet of seeds. Thus, breeding need not be synchronized with the availability of a particular food. The resultant protracted breeding season has led to a propensity for multiple brooding. Predation, probably, is of secondary importance in the evolution of columbid reproductive strategy (Westmoreland *et al.* 1986).

A pair of little brown doves was observed attempting nest construction over an electric bulb hidden behind a stone pillar on the verandah of my house. The adult birds brought the nesting materials for three days, but could not succeed as there was nothing to hold the nesting materials intact. To help them, I made a cup-like structure with split bamboo sticks and tied it above the electric bulb. Being disturbed, the birds moved to the neighbouring garden about 10 m away and made a nest in a *Capparis sepiaria* bush. Later,

the nest with the eggs was blown away in a dust storm.

A few days later on April 27, 1987, the adults came back and occupied the nest made with bamboo sticks. From April 1987 to March 1988, the same pair of birds used the nest nine times successively for nesting. The nesting was a complete success five times. The eggs were preyed upon once and the hatchlings died on three occasions. Multiple brooding details are given in Table 1.

Nesting behaviour: Both male and female birds actively participated in nest construction. The nest building was carried out for 2 to 3 hrs daily during the day time i.e. 0800 to 0900 hrs in the morning and 1500 to 1600 hrs in the evening. It was noticed that very little nest material was brought (5 to 10 twigs) when an old nest was reused.

Egg laying behaviour: On each nesting occasion, except the second time when only one egg was laid, the eggs were usually laid on succeeding days. If the first egg was laid in the evening the second was laid on the third day (as in the first nest). On all the occasions, except the first and the last, the time lag between first and second egg laying was one day. After laying the first egg, the female left the nest, leaving the egg unguarded. The incubation started immediately after the second egg was laid and thereafter the eggs were never left unguarded; except for a very short duration when the birds changed incubation duty.

Incubation pattern: The adult bird was colour marked while it was incubating. The underside of the tail feather was marked with Indian ink without catching and disturbing the bird. This was done by hiding beneath the nest and marking the underside of the tail feather with a swab dipped in Indian ink. This mark was visible clearly as the underside of the tail feather was white. It was noticed in the preceding nesting that the marked adult was a male. The unmarked adult was noticed laying the egg while the marked male usually incubated the egg during the day. The adult female incubated the eggs during the night and hence incubated for a longer duration. The change of incubating birds was

TABLE 1
DETAILS OF THE MULTIPLE BROODING OF *STREPTOPELIA SENEGALENSIS*

S. No.	Date occupied	Date of nest construction	First egg	Second egg	Hatching date	Leaving date of fledgling	Remark
1	27/04/87	29/04/87	02/05/87	04/05/87	17/05/87 & 18/05/87	01/06/87	Success
2	03/06/87	03/06/87	05/06/87	nil	19/06/87	05/07/87	Success
3	06/07/87	10/07/87	12/07/87	13/07/87	26/07/87	07/08/87	Success
4	08/08/87	11/08/87	16/08/87	17/08/87	01/09/87	nil	Died on 3rd day
5	04/09/87	28/09/87	01/10/87	02/10/87	15/10/87 & 16/10/87	30/10/87	Success
6	01/11/87	15/11/87	20/11/87	21/11/87	nil	nil	Preyed at egg stage
7	11/12/87	17/01/88	20/01/88	21/01/88	03/02/88 & 04/02/88	nil	Died on 4th day
8	08/02/88	13/02/88	15/02/88	16/02/88	29/02/88	nil	Died on 5th day
9	06/03/88	08/03/88	10/03/88	13/02/88	25/03/88	09/04/88	Success

observed between 0800 to 0900 hrs and 1500 to 1600 hrs depending on the season.

The fully fledged young ones left the nest after 9 to 12 days. The total incubation period was 13 to 14 days; a single nesting cycle (from the first egg laying to fledging) was 24 to 26 days. Nene (1979) reported the incubation period of the little brown dove as 13 to 14 days and the full fledged young ones left the nest after 12 to 16 days.

Renesting: It was observed that the nest occupation and construction varied between 0 to 24 days. The next nest occupation occurred within one to two days after fledging (Table 1). The nest construction was completed within two to five days. In mourning doves, after a nesting failure, the period until a new clutch is begun ranges from 2 to 25 days, the most frequent time interval being 6 days. Multiple brooding has been reported in mourning doves *Zenaida macroura*, which often attempts three to six clutches per breeding season (Hansen and Kossack 1963). By reusing old nests, columbids eliminate the time and energy required for building the nest. Mourning doves reuse nests in 35-48% of nesting attempts, but this does not improve nesting success. It is plausible that nest range evolved to reduce time intervals between nesting cycles (McClure 1950, Harris *et al.* 1963, Westmoreland *et al.* 1986). The reuse of an old nest twice by little brown dove has been recorded by Nene (1979), when the nest was reoccupied by adults within five to six days.

Individual columbids may eliminate nesting intervals by overlapping nesting cycles i.e. simultaneously caring for two sets of offspring at different stages of development (Murton and Issacson 1962, Burley 1980). But in the present study, the little brown dove did not have overlapping nesting cycles. It was observed that the same adult pairs reused the nest again and again. The faecal pellets of young ones piled inside the cup-like nest which finally became a platform.

Ali and Ripley (1983) reported that the breeding season of little brown dove is not defined, practically all year, chiefly January to October. Multiple brooding without overlapping is observed and one of the adults was sometimes noticed caring for the young ones as the other one started occupying the nest (1st, 2nd, 3rd and 5th nests).

In birds, the main moult generally follows the breeding season. The burden on the protein reserves of the birds for replacing the feathers is generally too high to accomplish at the same time as breeding. Only with abundant food supply do the two processes seem to occur simultaneously, as in many pigeons (Murton *et al.* 1974). The present study on *Streptopelia senegalensis* showed that adult birds were very weak with arrested moult, probably due to continuous brooding.

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10. ASHY MINIVET *PERICROCOTUS DIVARICATUS* (RAFFLES) IN KANHA NATIONAL PARK, MANDLA DISTRICT, MADHYA PRADESH

We were watching a mixed hunting party of birds during a nature trail near Kisli Gate, in Kanha National Park (Mandla district, Madhya Pradesh), early in the morning, on March 19, 1998, when we saw a grey and white minivet, perched right at the top of a sal *Shorea robusta*. Through the binoculars, we saw a long-tailed, bulbul sized bird, which had a prominent white forehead and a very small supercilium. It was otherwise grey on top and on the wings, and white below, immediately recognized as a female minivet *Pericrocotus divaricatus* — the white forehead being the characteristic feature of this bird and a total lack of any red, orange or pink in its plumage, being the other. We got a very good view as the bird was perched in full sunlight and 'co-operated' for at least three to five minutes before it flew off, when we saw some white in its wings. This is the first record of an ashy minivet for Kanha and also the first for Madhya Pradesh.

The only other reports of ashy minivet have been from the Andaman Islands (Butler 1899), Karnala, Maharashtra [31.i.1965 (Navarro 1965)]; Madras, Tamil Nadu [9.xii.1984 (Santharam 1985, 1986, 1988, 1990)]; Thekkady in Periyar Sanctuary, Kerala [17.xii.1989 (Robertson 1992)]; Himachal Pradesh [22.iii.1993 (Khacher 1994)]. Ours is, therefore, only the sixth record of the bird from India. In Madras, however, it is being seen regularly by Dr. Santharam in December and January in the Guindy National Park and Theosophical Society Estate.

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11. REDVENTED BULBUL *PYCNONOTUS CAFER* FEEDING ON TAIL OF HOUSE GECKO *HEMIDACTYLUS FLAVIVIRIDIS*

On July 26, 1990, while on duty in the World Forestry Arboretum, Jaipur, Rajasthan, at about 0900 hrs I observed a redvented bulbul (*Pycnonotus cafer*) repeatedly attacking a house gecko *Hemidactylus flaviviridis* on an external wall of my office building. To escape from danger, the gecko moved fast on the wall and tried to seek a safer place. After a few seconds, the gecko broke off its tail to divert the attention of the bulbul. The wriggling tail drew the attention of the bulbul immediately and soon the bird started feeding on it. Within five minutes, the bulbul completely devoured the tail and flew away.

According to Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) the redvented bulbul mainly feeds on fruits, berries, flower nectar, and insects. There is one report of parent bulbuls feeding their nestling on young *Calotes versicolor* (Richards, *JBNHS 25*:503). Feeding on the tail of a house gecko by an adult bulbul is quite unusual.

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12. COMMENTS ON THE BIRD LIST OF THATTAKAD BIRD SANCTUARY, KERALA

In his paper on the Birds of Thattakad Bird Sanctuary (*JBNHS 93(3)*: 487-506), R. Sugathan has included two species of birds which are unlikely to be seen in Thattakad.

The rufousbellied plaintive cuckoo (*Cacomantis merulinus*) — No. 87 — has been recorded only in northeastern India with a few records west from Bhutan and West Bengal (SYNOPSIS, Ripley 1982). Earlier, the Indian plaintive cuckoo was considered only a subspecies (*passerinus*) of *Cacomantis merulinus* and in his BIRDS OF KERALA (1969), Sálim Ali has referred to the Indian plaintive cuckoo by its old nomenclature. However, in 1951, Biswas (*Ibis 93*: 596-598) has shown that these two were indeed distinct species. These were then renamed Indian plaintive cuckoo (*Cacomantis passerinus*) and rufousbellied plaintive cuckoo (*Cacomantis merulinus*) and have since been accepted by Sálim Ali and S. Dillon Ripley. I wonder if the inclusion of the rufousbellied plaintive cuckoo in the Thattakad list was through an oversight.

The green munia (*Estrilda formosa*) — No. 264 — is restricted in its distribution to central India (SYNOPSIS, Ripley 1982). It has been included in A BOOK OF KERALA BIRDS Neelakantan (1993), with a question mark, based on a sight record from Wynaad. Its presence in Kerala is very unlikely, unless these were escaped cage birds.

The list also includes some birds for which additional notes on identification, sighting dates could have been given. For example, the two grasshopper warblers (*Locustella* spp.) — Nos. 218 & 219 — are said to be very difficult to locate and identify in the field. Have these species been mist-netted to clinch the identification? I also feel that the two species — jungle wren-warbler (*Prinia sylvatica*) and white throated munia (*Lonchura malabarica*) — Nos. 216 & 264 — are rather unusual records as these are birds of drier habitats (See habitat description in BIRDS OF KERALA).

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Editor's Note: R. Sugathan, who was sent a copy of this note, writes as follows:

In this regard I had written a letter on July 3, 1997, to the Editor, *JBNHS* saying that No. 87, rufousbellied plaintive cuckoo (*Cacomantis merulinus*) included in our bird list is an error. What was meant was *Cacomantis merulinus passerinus*.

The green munia (*Estrilda formosa*) is recorded from Thattakad in small numbers. The identification was confirmed by mist-netting the birds. For two consecutive years, we have been seeing around seven birds in our regular bird census. To clarify any doubt two of them were netted, examined and their identity confirmed. I never came across this species anywhere in my bird survey in Kerala except at Thattakad. That is why it was included in our list. It is possible that they are escapees.

The grasshopper warblers *Locustella certhiola* and *L. naevia* were caught by mist-net from Thattakad and their identity confirmed.

13. GANGES SOFT-SHELL TURTLE *ASPIDERETUS GANGETICUS* PREDATING ON NILGAI *BOSELAPHUS TRAGOCAMELUS* IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

On July 1, 1999, in the afternoon, while carrying out vulture survey in the Park, we saw a nilgai *Boselaphus tragocamelus* (Family Bovidae), in the Ghana Canal of the Park. The canal had shallow water but thick muddy silt. The nilgai was finding it difficult to walk and was struggling to get out. We noticed two big soft-shell turtles *Aspideretus gangeticus* (Family Trionychidae) pulling the nilgai down whenever it tried to get up. There were turtles all over, biting off chunks of flesh from the flanks, abdomen and legs. There was blood all over as the turtles had pulled out the entrails of the antelope. The nilgai kept up the struggle for more than an hour and a half, and finally it succumbed to its injuries. The forest guards tried to chase the turtles, but in vain.

The Ganges soft-shell turtles are known to be carnivorous and are attracted to rotting flesh (Daniel 1983). They take a wide range of food from vegetable to animal matter. They have been recorded taking waterfowl, millipedes, fish and flapshell turtles alive and scavenging on dead fish and mammals (Daniel 1983, Das 1985, Bhupathy 1990). We have not come across any reference in literature to the turtle actively predating on a live large mammal and we think it is worth recording. Probably, the nilgai was injured and the turtles were attracted to the smell of blood.

July 9, 1999

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14. STRANGE DEATH OF A SNAKE

On May 27, 1999 while watching grizzled giant squirrels (*Ratufa macroura*) in Chinnar Wildlife Sanctuary, I saw a dead snake lying entangled among the branches of a tamarind tree. At my request, the 'Hill Pulaya' accompanying me climbed the tree and brought the snake down. It must have been dead for at least a couple of weeks and was absolutely dry. Stuck in its mouth was a large *Calotes calotes,* about 40 cm in length (including tail) that had been almost completely swallowed. The hot dry climate of Chinnar — in May, day temperature reaches 38 °C — had mummified the snake and its prey.

The snake was identified as *Dendrelaphis tristis* (Family Colubridae). Its total length was 78 cm. The lizard could be seen clearly through the tautly stretched skin of the snake's neck region. Even the white bands on the lizard's green body were visible through the snake's stretched skin. The 20 cm long tail and the hind legs of the lizard were sticking out of the snake's mouth. The snake and its prey were remarkably undamaged. Two claws of the lizard's hind limb were stuck in the corner of the snake's mouth, and probably during its effort to regurgitate the prey, the claws of its right forelimb also penetrated the snake's gullet and skin, resulting in the death of the snake.

Behura (*JBNHS 50(1)*: 183) mentions a *Xenochrophis piscator* dying in a pond as a result of 'swallowing a 8.1 inch long fish' and probably getting the pectoral spines of the fish stuck in its mouth, so that it could not be swallowed or regurgitated. Snakes rarely choke to death on prey, for they can extend their wind pipe along the floor of the mouth to breathe during feeding, and also, they seldom tackle animals too big to swallow.

March 3, 2000

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15. SIZE ANALYSIS AND DISTRIBUTION OF JERDON'S BULL FROG *HOPLOBATRACHUS CRASSUS* (JERDON 1835) IN ASSAM

Hoplobatrachus crassus, a close relative of *H. tigerinus* (Family Ranidae), was recently reported from northeastern India by Bordoloi and Bora (1999). Earlier, the easternmost limit of distribution of *H. crassus* was West Bengal (Sarkar *et al.* 1992). It is possible that previous workers confused the two congeners and failed to record the former from parts of its range (Daniel 1975). The present communication deals with the distribution of *H. crassus* in Assam and provides a comparison of morphometric features of these two species.

Specimens of *Hoplobatrachus crassus* and *H. tigerinus* were collected using visual encounter surveys. A total of 73 man-hours were spent in collecting 23 adult (15 ♂ and 8 ♀) *H. crassus* and 49 adult (27 ♂ and 22 ♀) *H. tigerinus* during the breeding season (April to September, 1998). The date and time of collection, habitat and micro-habitat, and weather conditions were noted. Each specimen was measured for morphometric analysis. Statistical analysis (t tests) were carried out.

Hoplobatrachus crassus has a wide distribution in the Brahmaputra Valley of Assam, up to an altitude of 180 m above msl. It is most abundant in the flood plains, especially in waterlogged agricultural fields. Of 23 specimens collected, 12 were from paddy fields, 5 from wet grasslands, 3 from sugarcane fields, 2 from oxbow lakes locally known as *beels* and one from a moist open field with short broad-leaved grass. It was found on both banks of the Brahmaputra river: Sibsagar, Golaghat, Kamrup, Goalpara, Barpeta, Nalbari, Darang, Sonitpur and Lakhimpur.

TABLE 1
MORPHOMETRIC MEASUREMENTS (IN MM) OF *HOPLOBATRACHUS CRASSUS* (±SD)

SVL	76.4 ±7.7
HL	23.5 ±2.0
HW	26.1 ±2.15
HD	16.8 ±2.13
SL	11.4 ±1.5
EN	5.7 ±1.2
NS	4.6 ±0.6
IN	3.8 ±0.6
ED	6.8 ±0.59
HTYD	4.7 ±0.6
VTYD	4.9 ±0.45
TBL	27.3 ±3.4
T_4	32.5 ±3.7
IMT	4.5 ±0.5

TABLE 2
MORPHOMETRIC RATIOS OF *HOPLOBATRACHUS CRASSUS* AND *HOPLOBATRACHUS TIGERINUS*

	H. crassus	*H. tigerinus*
HL : SVL	0.31 ±0.01	0.34 ±0.03**
HL : HW	0.9 ±0.03	0.98 ±0.11*
HL : HD	1.41 ±0.01	1.53 ±0.22
SL : HL	0.48 ±0.4	1.51 ±0.04
EN : SL	0.50 ±0.05	0.46 ±0.04
ED : HL	0.29 ±0.02	0.28 ±0.05
ED : EN	1.24 ±0.23	1.17 ±0.15
IN : ED	0.55 ±0.08	0.59 ±0.10
HTYD : ED	0.70 ±0.09	0.79 ±0.19
HTYD : VTYD	0.98 ±0.09	0.99 ±0.07
TBL : SVL	0.36 ±0.02	0.45 ±0.05**
IMT : T_4	0.14 ±0.02	0.10 ±0.02**

* P < 0.10 (± tests); ** P < 0.05

SVL = Snout vent length, HL = Head length, HW = Head width, HD = Head depth, SL = Snout length, ES = Eye nostril length, ED = Eye diameter, IO = Inter orbital space, NS = Nostril snout length, IN = Intranasal space, HTYD = Horizontal tympanum diameter, VTYD = Vertical tympanum diameter, TL = Tibia length, IMT = Inner metatarsal tubercles, TBL = Tibia length, T_4 = 4th toe.

Hoplobatrachus crassus was reported only recently from Gohpur (92° 21' E and 26° 31' N), Assam (Bordoloi and Bora, 1999) and earlier workers failed to record it despite several surveys (Annandale 1915, Romer 1949, Smith 1929, Chanda 1994). The present study bridges the gap between West Bengal and Gohpur and reports a range extension of *c.* 150 km to the northeast.

The morphometric analyses (Table 1 and 2) of *Hoplobatrachus crassus* and *H. tigerinus* reveal significant variation only in the relative shape and length of head, tibia and inner metatarsal tubercles. The length of head and tibia of *H. tigerinus* are significantly higher (P < 0.05) than those of *H. crassus,* while the latter has larger inner metatarsal tubercle (P < 0.05) than the former. Further, the head length: head width ratio is also significantly higher (P < 0.10) in *H. tigerinus.* All other relative measurements did not exhibit any significant difference (Table 2).

Because of several shared external features, *H. crassus* was considered a subspecies of *H. tigerinus* by Boulenger (1920) and Kirtisinghe (1957). Bhaduri (1944) stated that unless an intergrade between these two could be discovered, *H. crassus* should be considered a distinct species. Dutta (1997) reported some morphologically intermediate specimens from southern India. The present study provides morphometric analyses for these two conspecifics and it is suggested that *H. crassus* can be differentiated from *H. tigerinus* by its brownish dorsum with long pleat-like folds; short snout, head and tibia; and large shovel-like inner metatarsal tubercles as opposed to a greenish-yellow dorsum with shorter folds; comparatively larger snout head and tibia and digit-like inner metatarsal tubercle.

Note: The specimens CND 79722, CND 79733, CND 79734, CDN 79735, MDT 6974, MDT 6977, MDT 7978, GOAL 7982, GOAL 8981, GOAL 8985, GOAL 8986, BDO 6973, BDO 6974, BDO 6975, KUR 6981, KUR 6982, KUR 6983, KUR 6984, KUR 6985, KUR 6986, KUR 6987, KUR 6988 are registered in the museum of Zoology Department, Arya Vidyapeeth College, Guwahati.

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16. FIRST RECORD OF THE SUNFISH *RANZANIA LAEVIS* (PENNANT) (PISCES : OSTEICHTHYES : PERCIFORMES : MOLIDAE) FROM THE WEST BENGAL COAST

A juvenile *Ranzania laevis* (Pennant) was caught in a trawl net on November 28, 1998, approximately 2 km offshore from Sankarpur harbour at Medinipur (= Midnapore) coast of West Bengal (21° 36' N, 87° 30' E) in the Bay of Bengal. The specimen (Regn No. MARC/ZSI/87) measured 494 mm in standard length. Depth of body 50.8%, head 37.65% in standard length, diameter of eye 15.05% in head length. Mouth aperture wide, measured 24 mm (vertical) and 13 mm (horizontal). Fin formula D.16, A.16, P.13, C.21, Pelvic fins absent.

Fraser-Brunner (1951) has reported its occurrence in all seas except polar seas. At the same time, he stated that the species is rather rare and its occurrence unpredictable. The sunfish (*R. laevis*) is distributed in tropical and subtropical waters of the Atlantic, Indian and Pacific Oceans (Nelson 1984). Chhapgar (1964) reported *Ranzania truncata* (Retzius) from the Mumbai (formerly Bombay) coast. In 1776, Pennant first described the sunfish as *Ostracion laevis*, and in 1785, Retzius described the sunfish as *Tetraodon truncatus* (op. cit. Fraser-Brunner 1951). Further, in 1798 Pennant described a specimen from Sri Lanka (formerly Ceylon) as *Balistes truncatus* (op.cit. Deraniyagala 1944). However, all the species were further synonymised as *Ranzania laevis* (op. cit. Fraser-Brunner 1951). Fraser-Brunner (1951) and Fischer and Bianchi (1984) stated that *laevis* is the only species under the genus *Ranzania*. Hence, the specimen described as *R. truncatus* (Retzius) by Chhapgar (1964) is the same species as *R. laevis*. Three more specimens of *R. laevis* were captured from the west coast of Sri Lanka (op. cit. Deraniyagala 1944). They were reported in 1798, 1911 and 1941 by Pennant, Pearson and Deraniyagala respectively, of which one was recorded from Katys harbour which is nearer the Indian coast. Scott (1983) in FAO species identification sheets (op. cit. Fischer and Bianchi 1984) mentioned the occurrence of the species only in fishing areas 34 and 51. Talwar *et al.* (1992) did not mention its occurrence from the coastal waters of West Bengal.

Hence, this is the first occurrence of *R. laevis* not only from coastal West Bengal, but from the entire east coast of India.

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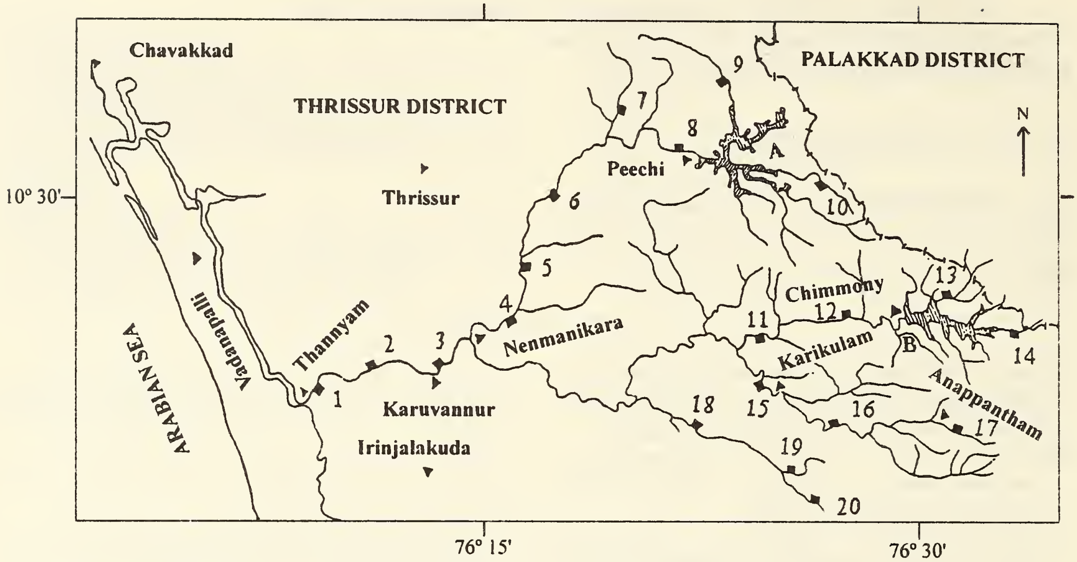
17. FISHES OF CHIMMONY AND PEECHI-VAZHANI WILDLIFE SANCTUARIES, KERALA, INDIA

(*With one text-figure*)

The Western Ghats immediately south of the Palghat gap are topographically complex and among the most heterogeneous areas in the entire Western Ghats with regard to bio-climatic zones, forest vegetation and endemic species (Nair 1991). Only by taking into consideration the complex topography of Parambikulam, Peechi-Vazhani and Chimmony Wildlife Sanctuaries in Kerala with the adjacent Anamalai Wildlife Sanctuary in Tamil Nadu can the full potential of this tract be realized. The fish fauna of Parambikulam Wildlife Sanctuary was reported by Biju *et al.* (1999). So far, nobody had studied the Peechi-Vazhani and Chimmony Wildlife Sanctuaries. The present survey indicates the diversity of the fish fauna in these Sanctuaries.

Chimmony Wildlife Sanctuary: The Chimmony Wildlife Sanctuary is situated in Mukundapuram taluka in Thrissur district (10° 22'-10° 29' N and 76° 25'-76° 34' E). This Sanctuary is a stretch of forest comprising of mainly evergreen forests, moist teak forests and moist mixed deciduous forests. The Chimmony Sanctuary, along the southwestern flanks of the Nelliampathies contiguous with and further south of Peechi extending east to Parambikulam, was declared as a Wildlife Sanctuary in August 1984. The Sanctuary area ranges in altitude from 50 to 1,116 m above msl (Nair 1991). The Chimmony Sanctuary is separated from the Parambikulam Sanctuary to its east by a stretch of forest along the catchment area of Kannankuzhithodu in Kodassery Reserve Forest.

Peechi-Vazhani Wildlife Sanctuary: The Peechi-Vazhani Sanctuary lies in Thrissur and Thalapilly talukas of Thrissur district (10° 28'-10° 40' N and 76° 17'-76° 29' E) (Nair 1991).



Collection sites:

1. Kilupillikara	7. Pattikad	13. Virakuthoda	19. Kurumala
2. Inchamudi	8. Cheenakadavu	14. Payambayar	20. Viranchira
3. Karuvannur	9. Puvanchira	15. Kundai	Reservoirs:
4. Manali	10. Olakara	16. Karikadavau	A. Peechi
5. Trikur	11. Anaipadam	17. Anappantham	B. Chimmony
6. Murkinikara	12. Inchipara	18. Munnumuri	

Fig. 1: Map of Karuvannur river showing various collection sites and reservoirs

This Sanctuary consists of parts of Paravattanimala Reserve, Machadmala Reserve and Bharanipachamala Reserve. The total area of the Sanctuary is 125 sq. km and is drained by Manali tributary of Karuvannur river (Peechi part) and Kechery river (Vazhani part). Two irrigation projects in the Sanctuary receive water from Peechi and Vazhani Reservoirs. The Peechi-Vazhani Wildlife Sanctuary has all the diversity and complexity of the Western Ghats gene resources. The vegetal spectrum ranges from truly evergreen patches to vast tracts of moist deciduous and semi-evergreen forests. The Sanctuary also contains some monoculture areas of teak plantations. The altitude varies from 30 to 928 m above msl. The highest peak inside the Sanctuary is Ponmudi which is a trijunction of Palakkad, Mukindapuram and Thrissur talukas. The endangered Nilgiri tahr found in the Ponmudi area and peacock are the main attractions within the Sanctuary area. The temperature ranges between 15 °C (during winter in hilly areas) and 38 °C (during summer in lowland areas).

Fish samples were collected from January 1997 to July 1998 from different localities in the streams and lakes. Fishes were collected mainly by using gillnets and cast nets. For collecting small fishes, a rectangular net with weighted edges was employed. Fishes were identified by visual observation and also in the laboratory. For laboratory identification, fishes were preserved in 10% formalin. Fishes were identified by referring to Day (1878), Jayaram (1981), Datta Muni and Srivastava (1988), and Talwar and Jhingran (1991).

Fish fauna: The systematic list of species is given below:

I Family: Anguilladae

1. *Anguilla bengalensis* (Gray)

II Family: Cyprinidae

2. *Catla catla* (Hamilton)
3. *Cirrhinus mrigala* (Hamilton)
4. *Cyprinus carpio communis* Linn.
5. *Labeo rohita* (Hamilton)*
6. *Puntius amphibius* (Val.)
7. *P. arulius* (Jerdon)*
8. *P. filamentosus* (Val.)
9. *P. melanampyx* (Day)
10. *P. sarana subnasutus* (Val.)
11. *P. ticto* (Hamilton)
12. *P. vittatus* Day
13. *Danio aequipinnatus* (McClelland)
14. *D. malabaricus* (Jerdon)
15. *Parluciosoma daniconius* (Hamilton)
16. *Garra mullya* (Sykes)

III Family: Balitoridae

17. *Nemacheilus guentheri* Day
18. *N. triangularis* Day

IV Family: Cobitidae

19. *Lepidocephalus thermalis* (Val.)

V Family: Bagridae

20. *Mystus armatus* (Day)
21. *M. malabaricus* (Jerdon)
22. *M. oculatus* (Val.)

VI Family: Siluridae

23. *Ompok bimaculatus* (Bloch)
24. *Wallago attu* (Schneider)

VII Family: Claridae

25. *Clarias batrachus* (Linn.)

VIII Family: Heteropneustidae

26. *Heteropneustes fossilis* (Bloch)

IX Family: Belonidae

27. *Xenentedon cancila* (Hamilton)

X Family: Aplocheilidae

28. *Aplocheilus lineatus* (Val.)

XI Family: Ambassidae

29. *Parambassis thomassi* (Day)

XII Family: Cichlidae

30. *Etroplus maculatus* (Bloch)
31. *Oreochromis mossambica* (Peters)

XIII Family: Gobidae

32. *Glossogobius giuris* (Hamilton)

XIV Family: Channidae

33. *Channa marulius* (Hamilton)
34. *C. orientalis* Bloch & Schneider**
35. *C. punctatus* (Bloch)**
36. *C. striatus* (Bloch)*

XV Family: Mastacembelidae

37. *Mastacembelus armatus* (Lacepede)

[* Recorded only from Peechi-Vazhani,

** Recorded only from Chimmony]

The present survey indicates the rich fish fauna in Chimmony and Peechi-Vazhani Wildlife Sanctuaries. A total of 37 species, belonging to 15 families, were collected from these Sanctuary areas. Of the 37 species collected, *Cyprinus carpio communis*, *Labeo rohita*, *Puntius arulius* and *Channa striatus* were recorded only from Peechi-Vazhani Sanctuary area, while *Channa orientalis* and *C. punctatus* were restricted to Chimmony Sanctuary. Four species were culture fishes, namely *Cyprinus carpio communis*, *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*. Most of the other species are widely distributed in Kerala and other parts of the Western Ghats. *Puntius filamentosus*, *P. melanampyx*, *Parluciosoma daniconius* and

Garra mullya were collected mainly from the streams adjacent to the reservoir.

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18. NEW RECORDS OF FISHES FROM THE WESTERN GHATS OF MAHARASHTRA

During studies on fish diversity in the Western Ghats streams and rivers in Maharashtra under the Western Ghats Biodiversity Programme, we collected *Silurus wynaadensis*, *Puntius bimaculatus*, *Puntius conchonius* and *Hypselobarbus dubius* from various streams and rivers. Recently, we recorded *Salmostoma sardinella* from Mondai stream and *Stigmatogobius oligactis* from Dhom reservoir as new records from Maharashtra and India respectively (Arunachalam *et al.,* 1999a,b). However, on further studies, we found four more species as new records from Maharashtra.

The above-mentioned fish species have not been recorded by earlier workers: Day (1868), Hora and Misra (1942), Suter (1944), Kulkarni and Ranade (1974), Jayaram (1981, 1991), Talwar and Jhingran (1991), Ghate and Pawar (1992) and Menon (1992).

Silurus wynaadensis Day

This species was originally described by Day (1873, 1878) in Wynaad, Kerala state (erstwhile Travancore). We collected one specimen from Mondai stream, which arises in the Mandhardevi hill ranges and meets the River Neerar. The fish was collected 1 km from Shirrai in Satara district. Bhimachar and Rau (1941) recorded this species from Jagger valley in Karnataka in the Cauvery and Tungabhadra river systems. Rajan (1955) reported this species from

the headwaters of the Bhavani river (Cauvery river basin) and Menon (1992) in Cauvery drainage at Virthy in Wynaad, Kerala State. Recently it is reported from the headwaters of Chandragiri, a west flowing river in Kasargod, Kerala (Gopi 1996), and by Arunachalam (1998) from Kallar river in south Kerala.

Description: D-4 P-i/10 V-i/7 A-i/56.

Body elongate and compressed. Head length 5 times in standard length. Upper jaw longer than lower jaw. Barbels three pairs; maxillary barbels extend over pectoral fins but do not reach base of pelvic fins; mandibular barbels two pairs. Eye diameter 5 times in head length.

Puntius bimaculatus (Bleeker)

This species was originally described by Bleeker (1844) from Ceylon. We collected one specimen from Phansad Wildlife Sanctuary, Murud Taluka, Raigad district. Talwar and Jhingran (1991) considered its geographical distribution from Sri Lanka only. Pethiyagoda (1991) described this species and its distribution in Sri Lanka. Menon and Rema Devi (1992) described this species from Kalakkad Wildlife Sanctuary, Tirunelveli district, Tamil Nadu. Arunachalam (1997) recorded its widest distribution in riverine wetlands of Tamiraparani. Rema Devi *et al.* (1997) also recorded it from Tamiraparani river system. We have recorded *P. bimaculatus* in the Western Ghats from Tamiraparani river, Gandana river, Rama Nadhi, Hanuman Nadhi, Karuppan Nadhi, New Falls and Moyar river (Nilgiri Biosphere Reserve) in Tamil Nadu, Hemavathi and Ekatchi rivers of south Karnataka (Arunachalam 1998) except Kerala.

Description: D-ii/10 P-i/10 V-i/6 A-i/5.

Body elongate, more convex dorsally than ventrally, depth 4 times in standard length. Head 3.8 times in standard length. Mouth small. Barbels one pair maxillary only, shorter than eye diameter. Dorsal fin inserted equidistant between tip of snout and base of caudal fin. Eye diameter 3 times in head length. Lateral line complete with 24 scales.

Hypselobarbus dubius (Day)

Originally described by Day (1867) from Bhavani river, Nilgiri hills, Tamil Nadu. We collected 2 specimens from Khal river, which originates from Bhira in Raigad district, Maharashtra. Recorded by Rajan (1955) from the headwaters of Bhavani river, south India. Johnsingh and Wickram (1987) recorded it from Mundanthurai Wildlife Sanctuary, Tamil Nadu. Recently it was recorded by Rema Devi *et al.*(1997) and Arunachalam (1998) from the Tamiraparani river system. This large barb is abundant in Bhavani river, Nilgiri hills, Tamil Nadu, and in the Tamiraparani river system. This species forms a major fishery in the Cauvery and Tamiraparani river systems.

Description: D-iii/9 P-i/14-15 V-i/8-9 A-ii-iii.5.

Body robust, its depth about four times in standard length. Eye moderate, diameter about 4.7 to 5 times in head length. Mouth subinferior, barbels two, rather short pairs. Dorsal fin inserted slightly nearer to snout tip than to base of caudal fin. Lateral line complete with 44 scales.

Puntius conchonius (Hamilton-Buchanan)

This species was originally described by Hamilton-Buchanan from ponds, and Kosi and Ami rivers of northeast Bengal. We collected 5 specimens from Dhom reservoir, a man-made impoundment of the Krishna and Vaitali rivers. Singh *et al.* (1987) recorded it from Garhwal Himalaya, Barman (1994) from Tripura, northeast India, and Johal *et al.* (1993) from Rajasthan. Recently it was reported by Arunachalam (1998) from Hemavathi and Ekatchi rivers, Western Ghats of south Karnataka.

Description: D-iii/7-8 P-i/14-16 V-i/8 A-ii-iii/5.

Body deep and compressed, its depth 2.8 to 3.5 times in standard length. Head 3.7 to 4.5 times in standard length. Mouth moderate; no barbels. Dorsal fin inserted equidistant between tip of snout and base of caudal fin, its unbranched ray osseous, moderately strong and serrated. Lateral line incomplete, ceases after 10th to 13th scale; 24-26 scales in longitudinal series.

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19. MANTID FAUNA OF SANJAY GANDHI NATIONAL PARK, MUMBAI, WITH SOME NEW RECORDS FOR MAHARASHTRA STATE

The Sanjay Gandhi National Park (SGNP) lies in the northern region of the Western Ghats, in a general north-south direction. It has a south Indian moist-deciduous forest type with a mean annual rainfall of 2,600 mm. The Park includes various habitats like mixed moist-deciduous forest with patches of pure bamboo, teak dominated forest including teak plantation, mangrove forest along the creek and western subtropical hill forest. Because of the variety of habitats, it is rich in insect fauna. However, very little is known about the insect biodiversity of the area. The mantid fauna of the Park and its environs is reported here.

Out of 162 species found in India (Mukherjee *et al.* 1995), the present study records 11 species from the Sanjay Gandhi National Park (SGNP), Mumbai, Maharashtra. The paper also provides measurements i.e. Body length (BL), Pronotum (PN) and Forewing (FW) of male (M) or female (F) of some species not recorded earlier.

The collection was made from 1995 onwards. The specimens were collected with nets. Mantids attracted to light at night were also collected. Only a representative collection was made; known species were caught and released after confirming the identification. The specimens so collected were identified according to Mukherjee *et al.* (1995). Some identifications were confirmed by Dr. T.K. Mukherjee.

The SGNP has 11 species belonging to 4 out of the 6 families of mantids found in India. One specimen collected earlier from Mumbai was identified as a species of *Empusa*, while another which was brought to us a few years ago from Pune by a student, was identified as *Ambivia popa* Stal. Some species like *Gongylus gongyloides* (Linn.) and *Creoboter gemmatus* (Stoll) prefer to sit on flowers of *Leea*, which attract hundreds of butterflies and other insects. *Hierodula* spp. prefer green vegetation, while *Humbertiella* spp. are found on the bark of trees.

All measurements are in mm.

A. **Family**: Amorphoscelidae Stal.

[1] *Amorphosclesis annulicornis* Stal.

Collection site: CEC Centre, Goregaon (E) adjacent to SGNP. 20.vi.1998.

Measurements: F: BL-17; PN-3; FW-14.

Distribution: INDIA: Assam, Bihar, Daman & Diu, Himachal Pradesh, Kerala, Meghalaya, Tamil Nadu, West Bengal. New record for Maharashtra.

B. **Family**: Hymenopodidae Chopard

[a] Subfamily: Acromantinae Giglio-Tos

[2] *Hestiasula brunneriana* Saussure

Collection site: Sanjay Gandhi National Park (SGNP), Mumbai, 12.vii.1998.

Measurements: F: BL-28; PN-4.5; FW-24.

Distribution: INDIA: So far recorded from Andhra Pradesh, Meghalaya, West Bengal. New record for Maharashtra.

[b] Subfamily: Hymenopodinae Giglio-Tos

[3] *Creobroter gemmatus* (Stoll)

Collection site: CEC, Goregaon (E), Mumbai. 24.viii.1998.

Measurements: M: BL-31; PN-7.5; FW-31.

Distribution: INDIA: Arunachal Pradesh, Himachal Pradesh, Sikkim, Uttar Pradesh. New record for Maharashtra.

C. **Family**: Mantidae Burmeister

[a] Subfamily: Liturgusinae Giglio-Tos

[4] *Humbertiella affinis* Giglio-Tos

Collection site: CEC, Goregaon, Mumbai, 12.vii.1998.

Measurements: M: BL-25; PN-6; FW-23. The earlier recorded measurement (Mukherjee *et al.* 1995) is of a female.

Distribution: INDIA: Karnataka, Orissa. New record for Maharashtra.

[5] *Humbertiella indica* Saussure

Collection site: SGNP, 11.v.1998.

Measurements: M: BL-31; PN-5.5; FW-26.

Distribution: INDIA: Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh.

[6] *Humbertiella nigrospinosa* Sjostedt

Collection site: SGNP. 5.ix.1998.

Measurements: F: BL-31; PN-8; FW-18.

Distribution: recorded from Orissa, Uttar Pradesh. New record for Maharashtra.

[b] Subfamily: Mantinae Kirby

Tribe: Miomantini Beier

[7] *Deiphobe infuscata* (Saussure)

Collection site: 1 male, 1 female from: SGNP, 11.v.1999 and 14.v.1999.

Measurements: M: BL-85; PN-23; FW-52
F: BL-87; PN-27; FW-22

Distribution: INDIA: Bihar, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Tamil Nadu, Uttar Pradesh. New record for Maharashtra.

[8] *Deiphobe incisia* Werner

Collection site: CEC, Goregaon (E) adjacent to SGNP. 6.viii.1995.

Measurements: M: BL-84; PN-24; FW-43.

Distribution: INDIA: Maharashtra, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh.

Tribe: Mantini Beier

[9] *Hierodula saussurei* Kirby

Collection site: Male and Female from SGNP. 12.vii.1998.

Measurements: M: BL-57; PN-18; FW-41
F: BL-74; PN-23; FW-48

Distribution: Arunachal Pradesh. New record for Maharashtra.

[10] *Hierodula* (*Rhombodera*) *butleri* Wood Manson

Collection site: SGNP, 7.vi.1998.

Measurements: M: BL-60; PN-18; FW-43.

Distribution: INDIA: Assam, Meghalaya, Sikkim, West Bengal. New record for Maharashtra.

D. **Family**: EMPUSIDAE Burmeister

[e] Subfamily: Empusinae Saussure

[11] *Gongylus gongylodes* (Linnaeus)

Collection site: SGNP. 10.xi.1995.

Measurements: F: BL-80; PN-41; FW-28.

Distribution: INDIA: Andhra Pradesh, Kerala, Tamil Nadu, West Bengal. New record for Maharashtra.

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20. RECENT RECORD OF *CREOBROTER APICALIS* SAUSSURE (INSECTA : MANTODEA) FROM PUNE, MAHARASHTRA AND KUMTA, KARNATAKA

(With one plate)

During 1997-98, we came across a very colourful mantis in the areas around Pune (Mulshi, Aundh Road, Kondhawa). We collected 3 specimens (all three females) from Pune and one in Santegully near Kumta (Karnataka). The taxonomic characters of the insect are given below.

Head triangular. Vertex with a small spine above ocelli. Frontal sclerite transverse, bicarinate and with central depressed area. Frontal sclerite with small, lateral wing-like expansions. Eyes large, conical, bulging beyond the circumference of the head. Pronotum with dentate lateral edge and prominent coxal dilation. Forecoxae with 6-7 small spines; forefemur with 4 external, 4 discoidal and 13 internal spines, all the spines brown-tipped. Femoral brush brownish, claw groove proximal. Foretibia with 15 external and 15 internal brown-tipped spines; of these, external spines bent at base and closely set; mid and hind femora each with a small lateral apical lobe. Forewings grass green, costal area translucent. Oblique oval, yellow patch bordered laterally by two black semicircular rings in the central part of each forewing. This so called 'eye mark' encloses 1, 2 or 3 black dots. Basal yellow patch on each forewing. Hindwings with characteristic colour pattern, costal area translucent yellow, base pink or purple, discoidal and anal areas brown with hyaline cross veins.

Body colourful. Head mostly greenish-yellow, vertex dark green. Pronotum dark green with a complete faint yellow border. All legs yellowish with olive-green bands. Meso- and metathoracic segments dorsally brown. First four or five abdominal segments pink in the mid-dorsal area, rest of the segments brownish (Plate 1, Fig. 1). Ventrally, thorax and abdomen uniformly greenish-yellow.

Measurements (in mm) of a Mulshi specimen: female, 21.vii.1998, coll. N. Rane, Body length 33.0; forewing 28, hind wing 25; prozona/metazona 3/4.5; forecoxa 8; forefemur 10.2; foretibia 5.3. The other two mantid specimens are very similar in morphometry.

With the help of a recent report on the fauna of Mantodea (Mukherjee *et al.* 1995) we could easily identify this interesting mantis as a species of *Creobroter*, on the following grounds. Family Hymenopodidae (external spines of the foretibiae numerous, bent and very closely set; forewing with eye-like mark); Subfamily Hymenopodinae (frontal sclerite with two lateral wing-like expansions and central depression; eyes bulging beyond the circumference of head); Genus *Creobroter* (ventral lobes of mid and hind femora occupy distal position only).

Specific determination of this insect was based on personal communication with Dr. T.K.

Mukherjee who was provided morphometric data and colour photographs. The species has been determined as *Creobroter apicalis* as the eye-mark is placed in the middle of the fore-wing.

There are, in all, 6 species presently under the genus *Creobroter* in India. *C. apicalis* has been reported earlier from Ambenali in Maharashtra (Mukherjee and Hazra 1983). The species is also known from Karnataka (Mukherjee *et al.* 1995) and our collection from Santegully, Kumta, (14.ix.1998 N. Rane) becomes an additional report, but from a definite locality in Karnataka State. All the specimens in our collection are females. Mukherjee *et al.* (1995) also record the examination of 23 females and of one male specimen.

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21. *SISYPHUS LONGIPES* (OLIVER) (COLEOPTERA : SCARABAEIDAE : SCARABAEINAE) — A NEW RECORD FOR ANDAMAN ISLANDS

The Andamans and the Nicobars, situated 1,200 km off the Indian mainland in the Bay of Bengal between 6° and 14° N and 91° and 94° E, though rich in insect fauna with several endemic species, dung beetles are very poorly represented on these islands. Only six species having been reported, namely *Catharsius molossus* L., *Copris spinator* Har., *Onthophagus cervus* F., *O. orientalis* Har., *O. unifasciatus* (Schall.), and *Paraphytus andamanus* Arrow (Arrow 1931, Veenakumari and Prashanth Mohanraj 1994). None of these species, however, belong to the dung roller group. We report the occurrence of *Sisyphus longipes* (Oliver), a dung roller of the Family Sisyphini from the Andaman Islands. A single specimen was caught in Garacharma, S. Andaman on January 25, 1998.

S. longipes has a wide distribution from Sri Lanka through central and eastern India to Burma (= Myanmar) (Arrow 1931). Many elements of the Andaman fauna (eg. a large percentage of the avifauna) are presumed to have arrived on these islands across the much narrower stretches of water that existed between Burma and these islands, as compared to any of the other neighbouring continental areas, during the Pleistocene sea level lowering (Ripley and Beehler 1989). If *S. longipes* had arrived on these

PLATE 1

H.V. Ghate *et al.* *Creobroter apicalis*

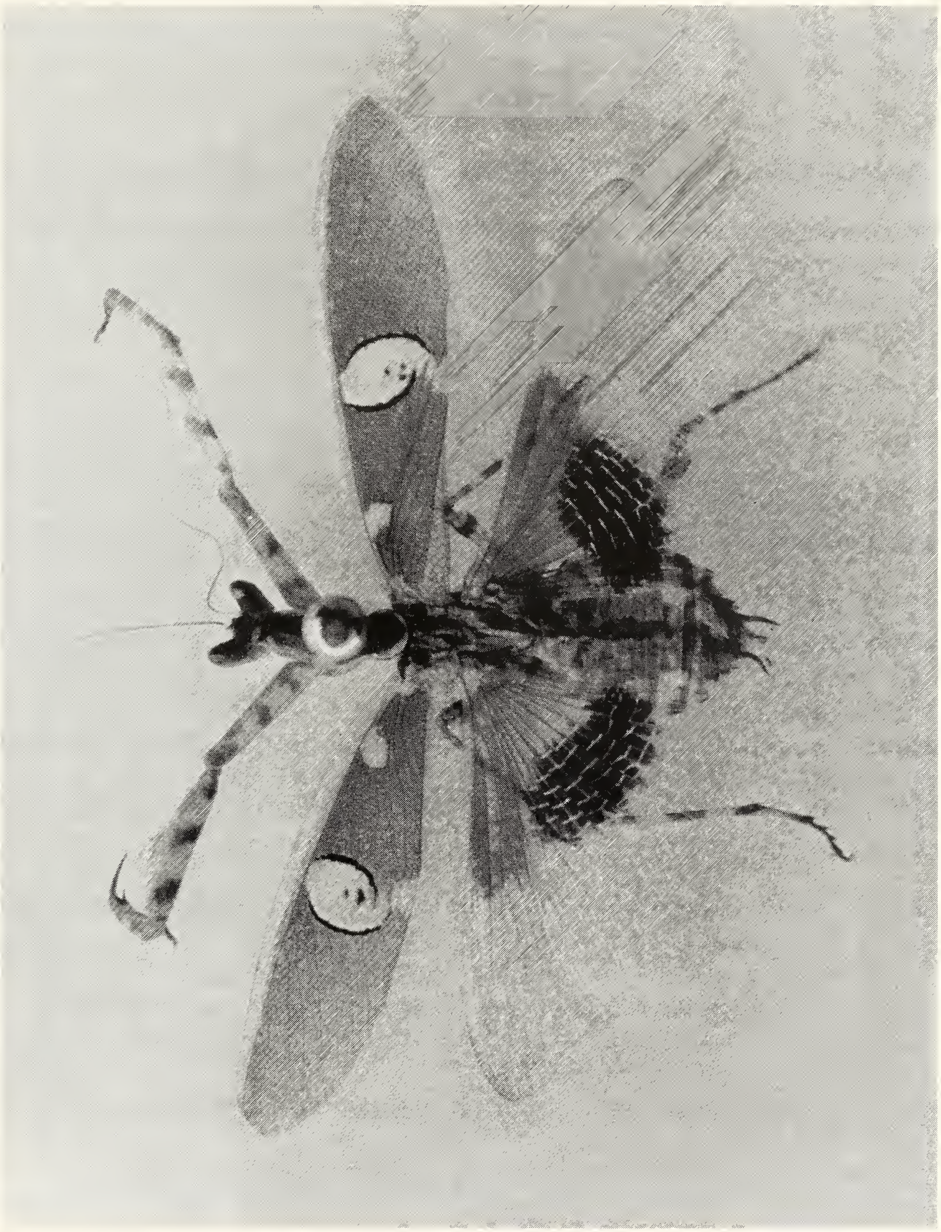

Fig. 1: *Creobroter apicalis* ♀, actual size 30 mm (length)

islands during that period and established itself here, then it must be a very rare species or one with cryptic habits, as we have not found any more specimens during our dung beetle surveys on these islands. This is likely as *S. longipes* is known to inhabit obscure places like the nests of ants (Arrow, 1931). In case the species has not yet established itself on these islands, the specimen collected by us may be part of the waif biota arriving on these islands or a vagrant, just like the dozen or so species of butterflies that Ferrar (1948) identified as vagrants on these islands. Further studies can establish the status of this species on the Andaman Islands.

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22. LARGE SCALE EMERGENCE AND MIGRATION OF THE COMMON EMIGRANT BUTTERFLIES *CATOPSILIA POMONA* (FAMILY : PIERIDAE)

During my journey on June 17, 1999, through the forest tracts between Mahasamund (Dist. H.Q.) to Tumgaon and Jhalap (NH 6), Madhya Pradesh, no less than five to six thousand Common Emigrant butterflies (*Catopsilia pomona*) were observed flying south to north at a moderate height of 0.60 m to 4 m above ground. At that time (1230 hrs to 1330 hrs) the sun was shining. This forest tract surrounds a big man-made reservoir named Kodar and has teak plantation patches in between the forest, on NH 6.

Interestingly, in the teak (*Tectona grandis*) patches, the butterflies were almost absent, whereas in mixed deciduous forest patches they were present in large numbers.

A few Mottled Emigrants (*Catopsilia pyranthe*) and Lime Butterflies (*Papilio demoleus*) were also flying with the Common Emigrants. It was noted that the swarm of butterflies seemed to be on a northward migration. During my return journey (1600 hrs to 1700 hrs) the sky was heavily clouded and it was drizzling; hardly 200 to 300 butterflies were seen on the same route.

Butterflies usually migrate northward to avoid the southwest monsoon. In this case, the migration may be due to premonsoon rain in the month of June. The locality had moderate rains in the past 15 days, but the monsoon was yet to set in. The large scale emergence and migration appeared to have started three months in advance. Also, the marked absence of the species in teak patches was interesting.

November 18, 1999

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23. *TRIDIDEMNUM* DELLA VALLE 1881, AN UNRECORDED GENUS OF COLONIAL ASCIDIAN FROM INDIA

(With one text-figure)

The occurrence of the genus *Trididemnum* Della Valle 1881 is reported for the first time from India. A preliminary survey of the seas adjoining the southeast coast from Tuticorin to Rameswaram, carried out in 1993-1994, showed the presence of 26 genera of ascidians. Of these, 21 genera have been reported prior to 1986 by earlier workers (Oka 1915, Das 1938, 1940, 1945; Sebastian 1952, 1955, 1956; Renganathan and Monniot 1984, Renganathan 1981, 1982a,b, 1984, 1986a,b, Renganathan and Krishnaswamy 1985), and 4 genera have been reported relatively recently (Meenakshi and Renganathan 1997, Meenakshi 1998). The present paper adds one more genus of ascidian — *Trididemnum* — as a new record for Indian waters.

Trididemnum cerebriforme Hartmeyer 1913

A single colony was collected from the undersurface of calcrete rocks in the littoral zone of Ervadi (9° 11' N; 78° 43' E) (Fig. 1).

Description: Colony flat, encrusting, irregular, measuring 3 x 2.5 cm, surface smooth, tough, milky white with patches of green cells. The green colour changed to yellow on preservation. The superficial test has a thin layer of bladder cells. Below this is a continuous layer of spicules. The remaining part of the test has sparsely distributed spicules, decreasing further towards the base of the colony. Spicules large, measuring 0.04-0.06 mm with 9-12 pointed rays. Basal test thin, common cloacal aperture conspicuous. Zooids 1.5-1.75 mm long. Both siphons well developed. Branchial siphon has sphincter muscles and 6- small lobes. The atrial siphon arises from the posterior dorsal surface of the thorax. Three rows of stigmata, with 8-10 stigmata in each row. The gut forms a single loop with a spherical stomach situated half way down the abdomen and a short posterior stomach. 8-10 bands of longitudinal muscles. Testis undivided. The proximal part of the vas deferens coils 4 to 5 times. No larva was observed in the single colony studied (Fig. 1).

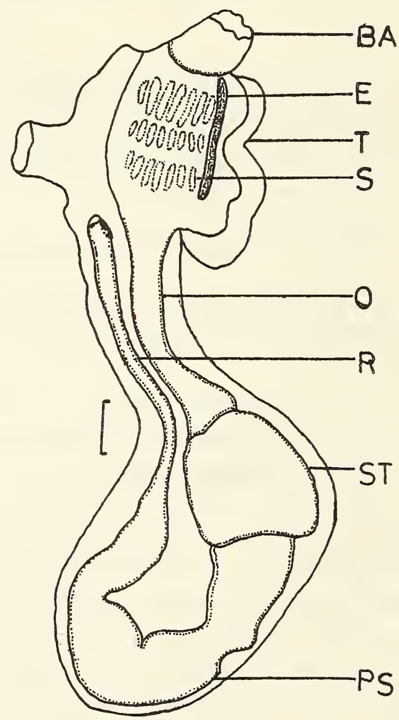

Fig. 1. *Trididemnum cerebriforme* - Zooid.
BA- Branchial aperture, E: Endostyle, T: Thorax, S: Stigmata, O: Oesophagus, R: Rectum, ST: Stomach, PS: Posterior Stomach.
Scale: 1 cm = 0.125 mm

Distribution: INDIA (Ervadi - ZSI-AS 13). Previously recorded from South Africa (Hartmeyer 1913, Millar 1955); southern Arabia (Kott 1957),

Australia (Kott 1962, 1972a,b, 1975, 1976); New Zealand (Michaelsen 1924); Philippines, Palau, Mariana, Hawaii Islands (Tokioka 1967); Japan Sea (Nishikawa 1990); Fiji (Kott 1981).

Remarks

The nature of the colony and the zooids of this specimen are identical with those previously described by Hartmeyer (1913), Millar (1955), and Kott (1976, 1981). The milky white appearance of the colonies, the posterior abdominal cloacal cavity, and the size of the spicules, their form and distribution, are characteristics of the present species.

Acknowledgements

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24. RANGE EXTENSION FOR *STROMBUS PLICATUS SIBBALDI* (SOWERBY) (MOLLUSCA : MESOGASTROPODA : STROMBIDAE)

The Phylum Mollusca is well represented along the Indian coast. Most of the available literature is old and based on collections made in the late 18th or early 19th century. It is, therefore, desirable to update the information on the status and distribution of Indian molluscs.

As a result of a survey along the Gulf of Kutch in 1993, I came across a shell which was identified as *Strombus plicatus sibbaldi* (Sowerby). More specimens were collected during subsequent surveys along this Gulf. The literature gives its distribution as the eastern coast of India, there being no record of its presence along the west coast.

Locality: Okha and Mithapur along the Gulf of Kutch.

Diagnosis: Size: 35-40 mm. Among the smaller species; spires very tall and slender on large body whorl. Each spire bears two strong vertical ribs with many fine riblets. Both lips strongly serrated on inner margin. Colour: White with brown mottling. Aperture white with light brown transverse striae.

Distribution: The species was previously reported from the Bay of Bengal and northern Indian Ocean.

Status: Rare.

January 27, 1999

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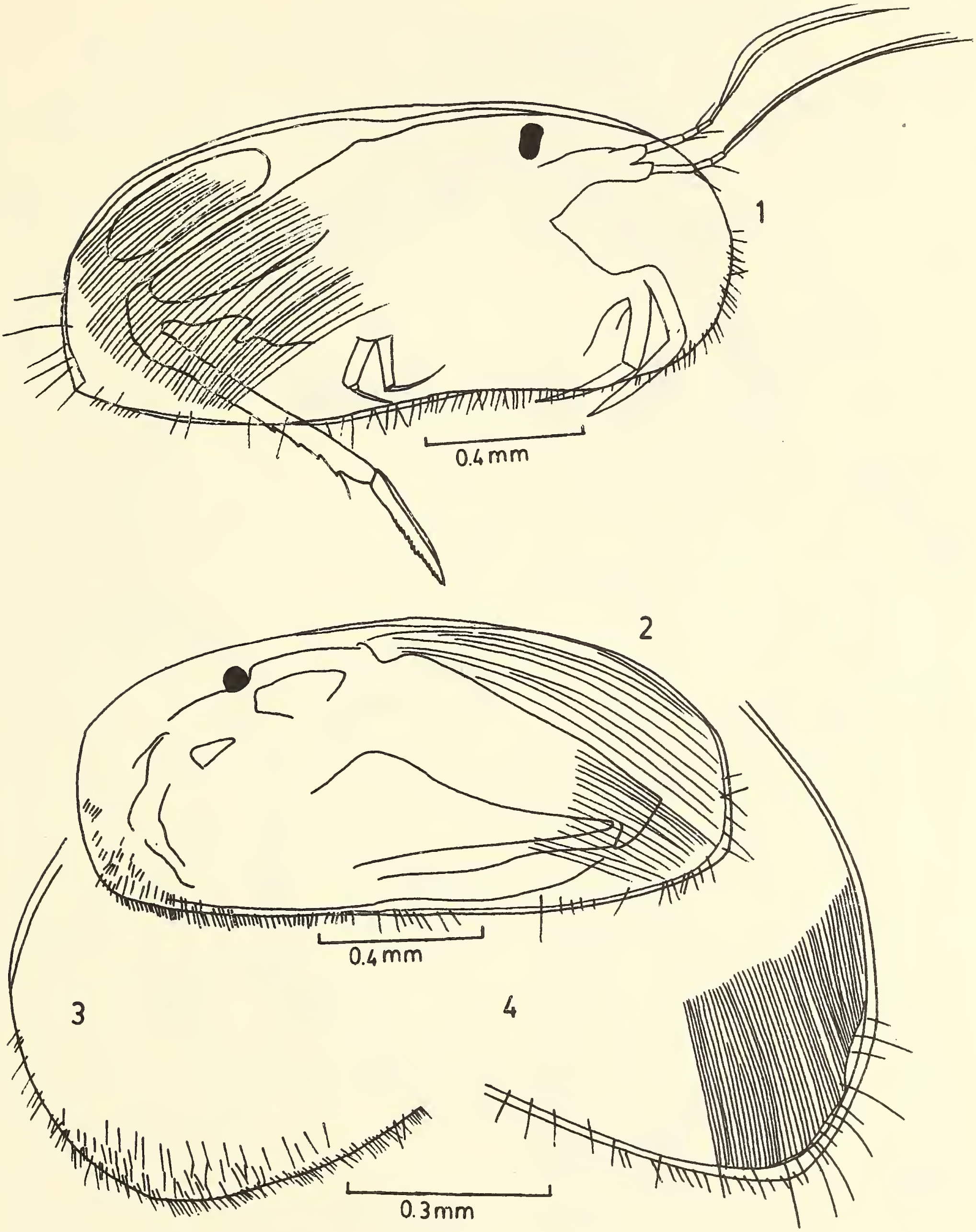
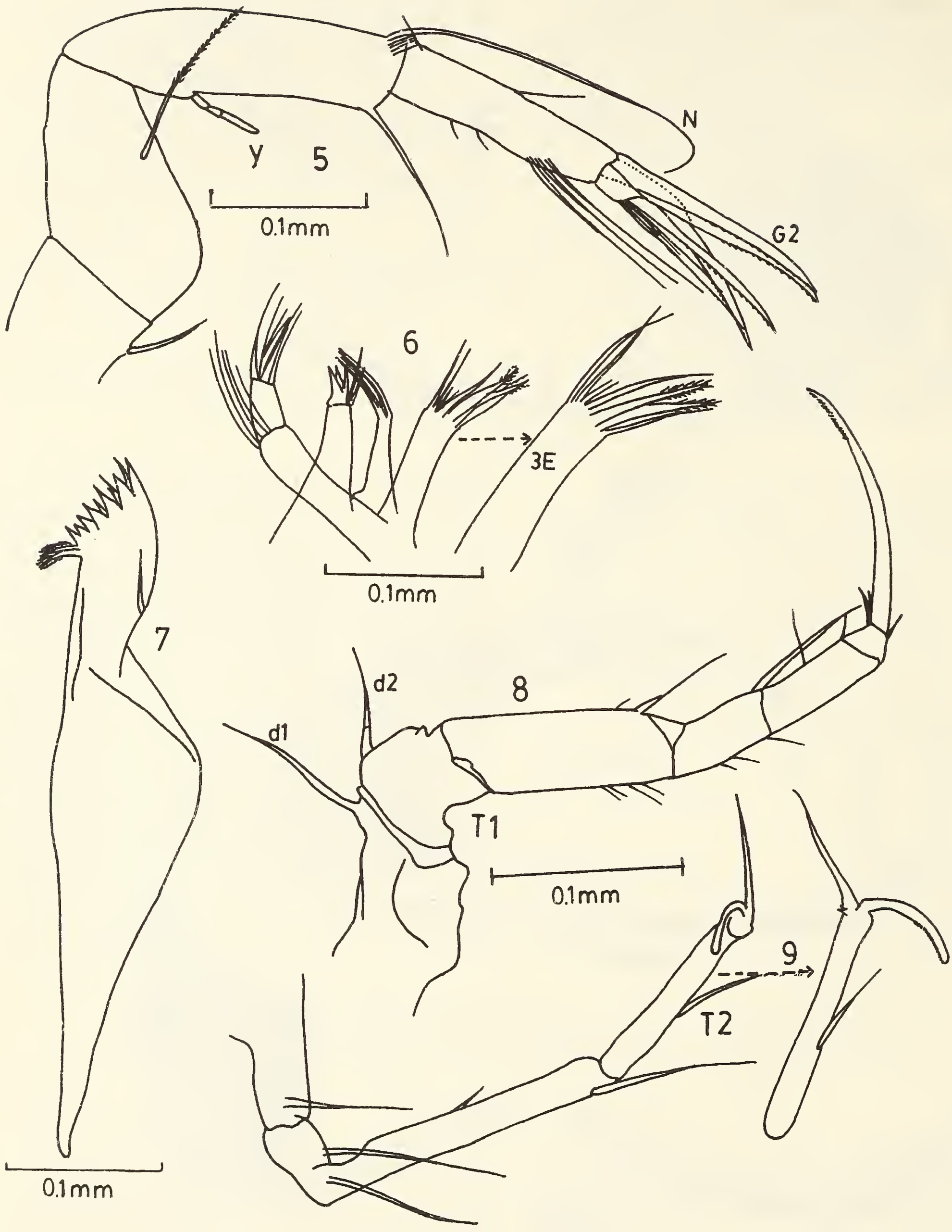
25. NEW RECORD OF *ASTENOCYPRIS PAPYRACEA* (SARS 1903), (CRUSTACEA, OSTRACODA) FROM WEST BENGAL, INDIA

(*With eleven text-figures*)

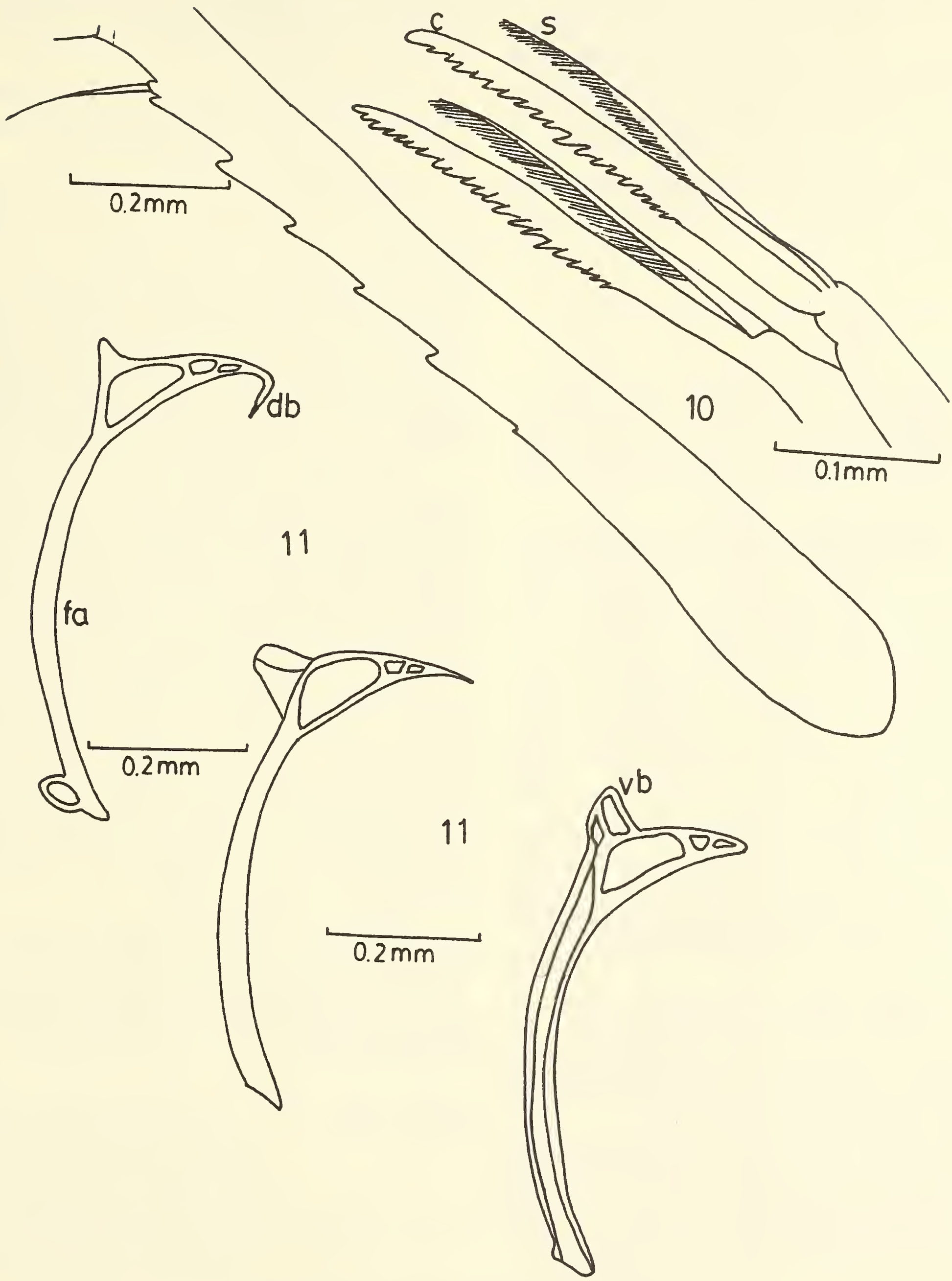
While studying zooplankton in the freshwaters of West Bengal, *Astenocypris papyracea* (Sars 1903) was found in one of the collections and is described and illustrated in this note. *Astenocypris papyracea* (Sars 1903) was first described from Sumatra and many other authors worked on this species, which belongs to Class Ostracoda, Subclass Podocopa and Order Podocopida. Muller (1912) changed the genus name *Leptocypris* to *Astenocypris* under the Subfamily Herpetocypridinae. Hartman and Puri (1974) referred the genus to Subfamily Dolerocypridinae. Victor and Fernando (1981) suggested that the genus *Astenocypris* does not



Figs. 1-4: *Astenocypris papyracea* (Sars 1903).
Female: 1. Right valve external view; 2. Left valve external view; 3. Anteroventral corner of valve; 4. Posteroventral corner of valve.



Figs. 5-9: *Astenocypris papyracea* (Sars 1903).
Female: 5. Antenna (A2) (N-natatory seta, G2-Shorter claw); 6. Maxillula (3E-third endite); 7. Mandible; 8. First thoracopod (T1); 9. Second thoracopod (T2)



Figs. 10-11: *Astenocypris papyracea* (Sars 1903).
Female: 10. Furca (S = Setae, C = Claw); 11. Triebel's loop, furcal attachment (fa)
(db = dorsal branch of fa; vb = ventral branch of fa).

belong to Dolerocypridinae. Broodbakker (1983) finally transferred this genus to the Subfamily Cypricercinae. Though *Astenocypris papyracea* was rediscovered in Kerala, South India by George and Martens (1993), the confusion still remains. The present study adds more information on the morphology of the shell and the trunk limbs, with more illustrations from the eastern part of India.

Astenocypris papyracea (Sars 1903)

Leptocypris papyracea Sars 1903: 29.

Astenocypris papyracea (Sars 1903) in G.W. Muller, 1912: 204; Victor & Fernando, 1981: 108-110; George and Martens, 1993: 29-31.

Material examined: Seven females from Salsalabari paddy fields, 10.x.1996, near Aliporeduar, on the way to Buxa Tiger Reserve, Jalpaiguri district, West Bengal.

Female; Body size 1.76 ±0.11 mm; Body width 0.80 ±0.06 mm (n=3). Valves long, dorsal margin nearly straight in anterior half, sloping towards caudal margin in posterior half, caudal margin slightly convex with ventral side projecting beyond dorsal corner, anterior margin broadly rounded, ventral margin almost straight with a concave margin towards the anterior side (Figs. 1-2). Lateral margin with thin striations. Anterodorsal corners and posterodorsal corners with thin hairs (Figs. 3-4).

Antenna with (A2) natatory setae not reaching tips of claws. 'Y' organ three segmented, and apical claw segment small with slightly shorter claw G2 (Fig. 5).

Maxillula (Mx1) with palp two segmented, distal segment with 5 setae; third endite with two serrated claws (Fig. 6).

Mandible with two segmented protopodite, a modified exopodite and a three segmented endopodite. The first podomere (coxa) with sclerotised teeth (Fig. 7).

The first thoracopod with d1 stout and longer than d2. Claw stout and slightly longer than the penultimate segment (Fig. 8).

Second thoracopod with longer claw (Fig. 9). Furca with six serrations on the dorsal margin and with a short seta at the distalmost serration (Fig. 10). Furcal claw stout and long with series of large teeth. Distal seta long, slightly shorter than claw, with a row of fine and delicate setae. Furcal attachment slightly curved with one large and two small Triebel's loops. Dorsal branch pointed and ventral branch club shaped (Fig. 11).

Remarks: The description given by George and Martens (1993) agrees well with the present material collected from the northeastern region, West Bengal. *Astenocypris* is placed within the Cypricercinae by Broodbakker (1983), based mainly on the presence of Triebel's loop in the furcal ramus. The present study agrees with George and Martens (1993) in placing the genus *Astenocypris* in the Subfamily Cypricercinae, since the characters such as the presence of three Triebel's loops, the variation in size of setae d1 and d2 on first thoracopod, striations in the valve and the solid furca are not uncommon in Cypricercinae.

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26. SOME RARE AND UNCOMMON LEGUMES FROM GARHWAL HIMALAYA

(*With three text-figures*)

Garhwal Himalaya is well known for its unique vegetation. The area has been explored by Hooker (1876), Duthie (1903, 1906), Osmaston (1927), Babu (1977), Naithani (1984), Polunin and Stainton (1985), Gaur (1987), Gaur *et al.* (1993), Dangwal and Rawat (1996), Dangwal *et al.* (1994, 1997). During recent plant explorations in the Garhwal Himalaya, we collected some interesting, rare and little known plants of the Family Faboidae (Papilionaceae).

The present communication gives illustrations of the newly recorded taxa, flowering and fruiting period, habitat, occurrence, approximate elevation range, availability and collector's herbarium number. The plant specimens, after being identified, were matched with authentic specimens from the regional herbaria housed at Botanical Survey of India, Northern Circle (BSD), and Forest Research Institute (DD), Dehra Dun. The voucher specimens are deposited at the Herbarium Department of Botany, H.N.B. Garhwal University (GUH), Srinagar (Garhwal).

Tephrosia candida DC., Prod. 2: 249. 1825; Baker in Hook. f., F.B.I. 2: 111. 1876; Duthie, Fl. Upp. Gang. Plain 1: 144. 1903; Osmaston, For. Fl. Kumaon 154. 1927; Sanjappa, Leg. Ind. 256. 1992. (Fig. 1).

Fl. & Fr.: August-January.

Distribution: Srinagar Garhwal, Uttar Pradesh, 580 m above msl.

Remarks: Rare, a limited number of plants occur in dry localities in open fields along with *Carrisa opaca*, *Rubus ellipticus*, *Mimosa himalayana*, *Rhus parviflora* and others.

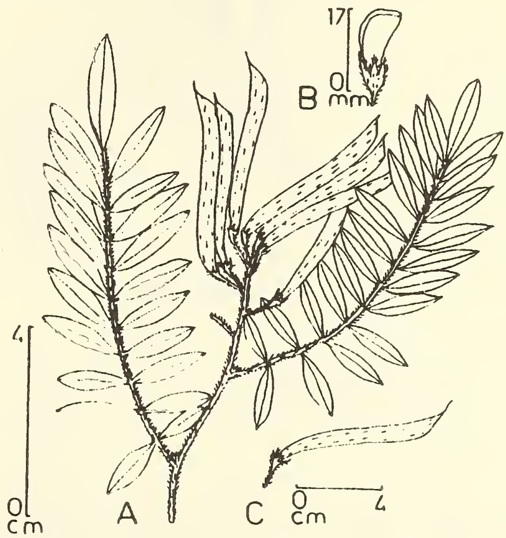

Fig. 1: *Tephrosia candida* DC.
A. Fruiting branch; B. Flower; C. Pod.

Specimen examined: L.R.D., G.U.H. – 12,296.

Notes: Hooker (1876) reported this species from tropical Himalaya to Sikkim and Duthie (1903) from Dehra Dun. However, Sanjappa (1992) mentioned its occurrence in tropical Himalaya to Sikkim, Bihar, Gujarat, Karnataka, Tamil Nadu, West Bengal, Sri Lanka, Nepal, Bhutan, Bangladesh, Burma, and New Zealand. This is a rare new record for Garhwal Himalaya.

Vicia tenera Grah. ex Benth. In Royle, Illust. Bot. Himal. 200. 1835; Baker in Hook. f., F.B.I. 2: 177. 1876; Sanjappa, Leg. Ind. 271. 1992. (Fig. 2).

Fig. 2: *Vicia tenera* Grah.
A. Flowering branch; B. Flower.

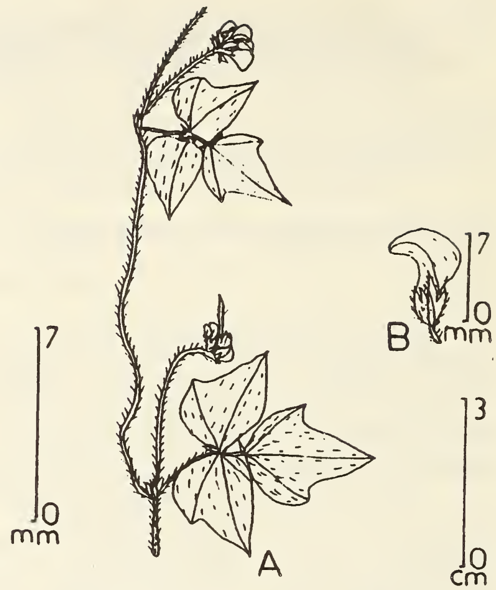

Fig. 3: *Vigna trilobatus* (L.) Verdc.
A. Flowering and fruiting branch; B. Flower

Fl. & Fr.: March-May.

Distribution: Matiyali, Pauri Garhwal, 700 m above msl.

Remarks: Uncommon, along roadsides and agricultural fields, in moist places with *Melilotus indica*, *Desmodium microphyllum*, *D. triflorum*, *Stellaria media* and grasses.

Specimen examined: L.R.D., G.U.H. – 16,300.

Notes: Hooker (1876) and Sanjappa (1992) reported this species from Western Himalaya (Simla) not stating any locality. This is a rare, new record from Garhwal Himalaya.

Vigna trilobatus (L.) Verdc., Taxon 17: 172. 1968; Naithani, Fl. Chamoli 1: 178. 1984. *Phaseolus trilobus* Ait.; Baker in Hook. f., F.B.I. 2: 201. 1876. (Fig. 3).

Fl. & Fr.: August-October.

Distribution: Chelusain, Pauri Garhwal, 1700 m above msl.

Remarks: Uncommon. A limited number of plants were found in dry and shady places on slopes, associated with *Carissa opaca, Berberis asiatica*, *Rubus ellipticus*, and *Rhus parviflora*, under *Pinus roxburghii* shelter.

Notes: Hooker (1876) reported it from Himalaya to Ceylon, Burma and Afghanistan. However, this is a rare collection after a long interval of more than 100 years.

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27. REDISCOVERY OF *WENDLANDIA ANGUSTIFOLIA* WIGHT EX HOOK.F. (RUBIACEAE), FROM TAMIL NADU, A SPECIES PRESUMED EXTINCT

(*With eleven text-figures*)

Wendlandia angustifolia Wight ex Hook.f., Family Rubiaceae, was first described by Hook.f. (1880) based on Wight's manuscript who collected it from Courtallum. Later, Rangachari collected it from Kannikatti in 1917. Deb and Maiti who revised the genus opine that the species is presumed extinct, and efforts should be made to relocate it in the river beds at low altitudes, to introduce it in botanic gardens to conserve the species. However, the species was rediscovered after a lapse of 81 years, in its known habitat at Inchikuzhi near Kannikatti during an inventory of threatened plants of the Kalakkad Mundanthurai Tiger Reserve (KMTR), Tirunelveli district, Tamil Nadu, in 1998. The species is described and illustrated.

Wendlandia angustifolia Wight ex Hook. f., Fl. Brit. India 3: 40. 1880; Gamble, Fl. Pres. Madras 588. 1921 (repr. ed. 2: 415. 1957); Deb & Maiti in Nayar & Sastry, Red Data Book Indian Pl. 1: 348. 1987.

Shrub or tree, up to 4 m high. Leaves ternately whorled, linear-lanceolate, attenuate at base, entire at margin, acute at apex, 4-11 x 0.5-1.8 cm, coriaceous; lateral nerves 6-8 pairs; petioles up to 1 cm long; stipules triangular-ovate, subulate or cuspidate at apex, persistent, 3-5 x 0.8-1 mm. Inflorescence at terminal branches, in panicles; panicles slender, pyramidal, leafy below; flowers densely crowded; bracts ligulate, hastate at base, acuminate at apex, 0.7-0.9 x 0.3-0.5 mm. Calyx tube turbinate, 4 to 6 lobed, *c.* 0.9 x 1 mm; lobes subulate, subequal, triangular ovate in outline, subulate at apex, *c.* 0.6 x 0.2 mm. Corolla white, salverform, 4 to 6 lobed, *c.* 4 x 1.2 mm; lobes orbicular, obtuse or slightly notched at apex, *c.* 1.1 x 1.1 mm. Stamens 4-6, epipetalous, between corolla lobes

Figs. 1-11: *Wendlandia angustifolia*: 1. A twig; 2. Inflorescence; 3. Flower; 4. Bract; 5. Calyx; 6. Calyx split open; 7. Corolla split open; 8. Anthers dorsal and ventral sides; 9. Ovary; 10. Fruit; and 11. Seeds.

exserted; filaments 0.75 x 0.8 mm; anthers pale yellow, oblong-ovate, dorsifixed, *c.* 1 x 0.6 mm. Ovary inferior; style linear, 4.5-5.8 x 0.15-0.2 mm; stigma 2-lobed, clavate, *c.* 0.8 x 0.6 mm. Fruits globose, rugose, many-seeded, *c.* 2 mm across; seeds brown, irregularly oblong-trigonous or trigonous, *c.* 0.3 x 0.2 mm.

Note: According to Hook.f. (1880) and Gamble (1921), flowers are either 4- or 5-merous. But the flowers in the recent collection show 4- or 6- merous conditions. Anther colour yellow is recorded for the first time. Sporadic populations can be seen along the stream and river beds between Inchikuzhi and Mundanthurai in the KMTR.

Specimens examined: Tamil Nadu: Tirunelveli district: Mundanthurai, 16.iii.1917, Madras Herbarium South Indian Flora (without collector and *sine numero*) 14628 (MH Acc. No.); Kannikatti, 19.iii.1917, Madras Herbarium South Indian Flora (without collector and *sine numero*) 14663 (MH Acc. No.); Inchikuzhi, +1,000 m, 16.ii.1998, M.B. Viswanathan, E. Harrison Premkumar and N. Ramesh 1641; Inchikuzhi, +1,000 m, 24.v.1998, M.B. Viswanathan, E. Harrison Premkumar and N. Ramesh 2010.

ACKNOWLEDGEMENTS

We thank Dr. N. Sukumaran, Professor & Head of our Centre, for encouragement, Thiru K.P.S. Katwal, I.F.S., Addnl. Chief Conservator of Forests & Chief Wildlife Warden, Chennai, and Dr. V.K. Melkani, I.F.S., Field Director & Conservator of Forests, Project Tiger, Tirunelveli, for permission to collect plant specimens for authentication.

June 14, 1999

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28. *LACTUCA GRACILIFLORA* DC. (ASTERACEAE) — AN ADDITION TO THE FLORA OF HIMACHAL PRADESH

During a systematic survey of the flora of Kulu district (Himachal Pradesh) in 1988-1992, 930 species of spermatophytes were gathered. Out of these, 32 species were found to be additions to the flora of Himachal Pradesh (Sharma and Dhaliwal 1997). Meanwhile, a specimen collected from the district was identified at Kew Herbarium as *Lactuca graciliflora* DC. A perusal of Chowdhery and Wadhwa (1984) and subsequent reports (Sharma and Dhaliwal 1997) revealed that this taxon has not been reported from the State. Further, in the most recent work on the Asteraceae of India, Mamgain and Rao (1995) mention the distribution of this species from Uttar Pradesh, West Bengal and Sikkim. Earlier, Hooker (1881) had recorded it from Central and Eastern Himalaya. Apparently, our record is a westward extension of the species. Information about the specimens collected is given below.

Lactuca graciliflora DC. Prodr. 7:139.1839; Hook.f. Fl. Brit. India 3:406.1881; Mamgain and Rao in Hajra *et al.* Fl. India 12:289. f. 71.1995.

Description: Glabrous or minutely hairy annual or biennial herb, 0.8-1.5 m tall. Leaves 5-15 x 2-5 cm, membranous; lower triangular, pinnatifid or pinnate, narrowed to a slender petiole; uppermost ovate or lanceolate, sessile. Inflorescence a terminal panicle, 30-60 cm long. Heads 1-1.3 x 0.1-0.2 cm, pink or pinkish-purple, drooping, with small slender peduncles. Outer

involucral bracts 1-1.5 x 0.5-1 mm, ovate; inner about 1 x 0.15 cm, linear-oblanceolate or oblong. Achenes 3.5-4 mm long, narrowly oblong or oblanceolate, smooth, constricted at the top into a stout beak. Pappus 5-6 mm long, pale white, deciduous.

The taxon under discussion belongs to section *Mulgedium* Cass., which is characterised by drooping, narrowly cylindrical heads in large terminal panicles with outer involucral bracts very small and inner ones long. Within this section, *Lactuca graciliflora* has leaves sessile or narrowed to a slender petiole and small achenes that are constricted into a short, stout beak. In other Indian species of the section, the leaf has a long winged petiole, which is dilated and auricled at the base, and the elongated achenes merge with the beak.

Fl. & Fr.: August-November.

Ecology: A high altitude species, collected on alpine slopes at 3,000-4,000 m above msl.

Illustration: Mamgain and Rao (*loc. cit.*).

Material examined: Jalori Pass, coll. D.S. Dhaliwal 15500 (PUN).

ACKNOWLEDGEMENT

We are obliged to Dr. V.J. Nair, Indian Liaison Officer at Kew Herbarium for the identification.

June 13, 1998

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SHARMA, M. & D.S. DHALIWAL (1997): Additions to the flora of Himachal Pradesh from Kulu district. *J. Bombay nat. Hist. Soc. 94(2)*: 447-450.

29. *ANAPHALIS BUSUA* (BUCH.-HAM. EX D. DON) DC., (FAMILY: ASTERACEAE) — AN INTERESTING NEW RECORD FROM BIJNOR (U.P.), INDIA

The genus *Anaphalis* DC (Family Asteraceae) comprises about 35 species and in India all except one are confined to higher altitudes between 1,320 m and 5,610 m. *Anaphalis busua* is reported from Dehra Dun (990-1,320 m), Himalaya (1,800-3,600 m), Nainital (1,920 m) and Simla (2,190 m).

During a survey of the flowering plants of Bijnor, a district of western Uttar Pradesh (29° 2'-29° 58' N, 78° 0'-79° 5' E) 218-275 m above msl, a small population of *Anaphalis busua* was found at Balawali, growing on an embankment of the River Ganga. A brief description of the taxon and other pertinent data are given here.

Anaphalis busua (Buch.-Ham. ex D. Don) DC. Prodr. 6: 275.1838. *Gnaphalium busuam* Buch.-Ham. ex D. Don Prodr. 173.1825. *Anaphalis araneosa* DC. Prodr. 275.1838; Fl. Brit. Ind. 3: 283.1881.

An erect, branched herb up to 1 m high. Leaves linear-lanceolate, white woolly abaxially, margins revolute, apex acute, unicostate, sessile base decurrent. Capitula in large terminal corymbose clusters, fragrant; each head *c.* 3.5 cm across, involucral bracts white-woolly, obtuse.

Fl. & Fr.: September-December.

Material examined: Athar s.n. Balawali;

Department of Botany Herbarium, Aligarh Muslim University, Aligarh.

This is the first record of the taxon at such a low altitude (218-275 m above msl).

December 27, 1999 ATHAR ALI KHAN
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30. THE IDENTITY OF *HYGROPHILA BENGALENSIS* MANDAL *ET AL.*, (FAMILY: ACANTHACEAE)

Mandal *et al.* (1997) described a new species of *Hygrophila* Br. (Acanthaceae) namely *H. bengalensis* Mandal Bhattacharjee *et* Nayek based on the collections of S.K. Mandal from Gorekhara, Sonarpur, 24-Parganas (South), West Bengal.

While establishing the new taxon, the authors stated that the new species is allied to *H. salicifolia* Nees and it differs in having "obovate to elliptic lanceolate leaves with undulated margin; yellow flowers; persistent calyx with marginal hairs; long slender style with articulated stigma; seeds 24-30, arranged alternately, attached by the recurved hook-shaped retinacula. Seeds testa with mucilaginous woolly hairs; arillated at the top, and ventrally notched." But a careful study of the protologue reveals that the morphological characters of *H. bengalensis* Mandal *et al.* are identical with *H. erecta* (Burm. *f.*) Hochr. Study of the type and other specimens deposited at (CAL) also revealed that this newly described taxon *H. bengalensis* Mandal *et al.* is identical with *H. erecta* (Burm. *f.*) Hochr.

Further, it is to be noted that some of the differentiating characters like "persistent calyx"; "recurved retinacula" and "testa with mucilaginous woolly hairs" are the common generic characters of *Hygrophila* Br. Moreover, none of the type specimens of *H. bengalensis* Mandal *et al.* have the "obovate leaves" as mentioned in the protologue.

Since *H. bengalensis* Mandal *et al.* and *H. erecta* (Burm. *f.*) Hochr. are conspecific, *H. bengalensis* Mandal *et al.* becomes a superfluous name of *H. erecta* (Burm. *f.*) Hochr. The present status of *H. bengalensis* Mandal *et al.* is as follows :

Hygrophila erecta (Burm. *f.*) Hochr. in candollea 15: 210. 1935.

Ruellia erecta Burm. *f.*, Fl. Ind. 135. *t.* 41, *f.* 3.1768.

Type: Rheede, Hort. Malabaricus 9 : 119. *t.* 61. 1669 (Repr. - 2 : 89. *f.* 46. 1983).

Hygrophila quadrivalvis Nees, Pl. Asiat. Rar. 3 : 80. 1826; Clarke in Hook. *f.* Fl. Brit. India 4. 408. 1885.

Type: *Wall. Cat. num. list no.* 2374, 2374B-D microf. – CAL!

H. bengalensis Mandal *et al.* in *J. Bombay nat. Hist. Soc. 94(3)*: 546-548. 1997 *Syn. Nov.*

Type: Holotype – Gorekhara, Sonarpur, 24-Parganas (S). West Bengal. S.K. Mandal; 30.i.1996; 1216A (CAL!) isotype – 1216 B-D (CAL!).

November 15, 1998 S. MITRA
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■ ■ ■

ERRATA

Kindly replace the contents page of Vol. 97(1), April 2000, with the page overleaf

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CONTENTS

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CONTENTS

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DECEMBER 2000 Vol. 97 (3)

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CONTENTS

NEW DESCRIPTIONS

REVIEWS

MISCELLANEOUS NOTES

Cover photograph: Lion-tailed Macaque *Macaca silenus* by Ajith Kumar

Editorial

From being virtually unknown in the early 1960s, the lion-tailed macaque *Macaca silenus* (Linn.) is today one of the most studied species in India. Interest in the lion-tailed macaque began following a 3-month study by Y. Sugiyama in 1965, in the Cardamom hills. It was not until a decade later, however, that the first long-term ecological study on the species began, by Steven Green in Agasthyamalai hills. Perhaps the establishment of a field station in Indira Gandhi Wildlife Sanctuary in 1978, by G.U. Kurup of the Zoological Survey of India, was a turning point in research on the lion-tailed macaque. This paved the way for several studies, on the species, in the Anamalai hills, in the next two decades. The only long-term study, on the species, outside of this area, was in the Silent Valley by K.K. Ramachandran and Jiji Joseph of Kerala Forest Research Institute.

Nearly three decades of research has considerably increased our knowledge on all aspects of the species, and its conservation problems. Among the first achievements was an upward revision of the geographical range, as well as of the wild population. Whereas Steven Green estimated the wild population to be about 600 animals in 1977, studies in the Anamalai hills and surveys in other parts, in the 1980s, gave an estimate of 4,000-5,000 animals. Particularly important in this context was a brief survey by Ullas Karanth, which reported a potentially large population in Karnataka, an area that was considered unimportant by Steven Green. Recent surveys by Mewa Singh and his colleagues indicate that the northern limit might extend considerably beyond the Sharavati river.

We now have a better appreciation of the adaptations of the lion-tailed macaque to the relative stability of the tropical rain forest, in the Western Ghats, to which it is endemic. Since it meets its energy needs primarily from simple carbohydrates in fruits, and protein from foliage insects, the high plant species richness and large areas of habitat, in the tropical rain forest, is critical for the survival of the species. With a remarkably low birth rate and high age at first birth, it is incapable of rapid population growth, and is critically dependent on low mortality rates for survival. Viewed in the light of its adaptations, the higher population estimate that we now have does not make us very optimistic. This is because the tropical rain forest, in the Western Ghats, has been severely fragmented and logged, and hunting is chronic in many places, all factors to which the lion-tailed macaque is ill-adapted. Studies in the last decade on the small isolated populations, in the Anamalai hills, show that many of these might be declining as indicated by very low birth rates and a low proportion of immatures in the population.

The same studies, however, also reveal the extent of adaptive flexibility of the species, and the possibility that with a lot of will and some ingenuity we can retain the populations in forest fragments. The lion-tailed macaque has responded to the drastic reduction in foliage insects, in the forest fragments, by shifting to invertebrates and lower vertebrates, such as lizards and skinks on the forest floor. It has responded to the drastic reduction in habitat area and plant species richness in forest fragments by feeding on fruits of plants cultivated around the fragments, such as coffee and jack-fruit, or weeds such as lantana or other colonising species on the forest edges. Thus, populations in forest fragments with more 'friendly' edges have fared better than those which do not, for example a fragment surrounded by tea estates. It is possible, therefore, to retain the species in relatively small patches of forests, if we promote land use practices that are friendly to conservation.

Studies on amphibians, reptiles, birds, rodents, small carnivores, flying squirrels, and butterflies have followed those on the lion-tailed macaque in forest fragments, in the Anamalai hills. These attempts reveal the complex ecological changes, in the animal communities, that are taking place in the forest fragments, changes that include extinctions, invasions and decline, as well as increase in densities. More importantly, these small fragments of forests have been found to retain many endemic species of lower vertebrates, even several decades after the landscape was severely fragmented. Many of these may not occur elsewhere. New species of amphibians have also been described from these patches of forest (e.g. *Rhacophorus psuedomalabaricus*, by V. Karthikeyan). There is now thus, a far greater appreciation of the conservation values, for the rain forest patches, in the Western Ghats.

Our understanding of the basic ecology, life-history and behaviour of the lion-tailed macaque has increased so much after nearly three decades of research, that this species has now become an ideal model to examine many interesting ecological and behavioural processes. The amazing variety of landscape situations, which the species inhabits also provides an ideal experimental setup. The ongoing research agenda for the species includes parental investment, host-parasite relationship in fragmented populations, genetic consequences of population fragmentation, reproductive physiology and behaviour in small populations, dominance interactions, plant-animal interactions, and resource partitioning. Several research organisations and forest departments are involved in this effort. Realizing that the management of small populations in the wild has a lot in common with the management of captive populations, there is also a move to put into practice the lessons learnt from research in the wild, in establishing a captive breeding colony. Apart from the conservation of the lion-tailed macaque, research on this species, in the coming years, would address issues in basic sciences, as well as ecological, behavioural and other processes that affect the survival of fragmented populations. An understanding of these processes is necessary in the context of the extinction crisis, facing us today, resulting largely from habitat fragmentation.

AJITH KUMAR

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December 2000 | Vol. 97 | No. 3

DISTRIBUTION, DEMOGRAPHY AND CONSERVATION STATUS OF THE INDIAN SARUS CRANE (*GRUS ANTIGONE ANTIGONE*) IN INDIA[1]

K.S. Gopi Sundar, Jatinder Kaur and B.C. Choudhury[2]

(*With nine text-figures*)

Key words: Indian sarus crane, *Grus antigone antigone*, encounter rate, distribution, breeding population, recruitment, habitat use, conservation.

A district-level survey to determine the distribution, demography and status of the Indian sarus crane (*Grus antigone antigone*) was carried out between June 1998 and March 1999 in the states of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Maharashtra. The survey discovered populations in Jammu & Kashmir and Himachal Pradesh, which are areas where sarus cranes have not been recorded since 1983. A total of 1,761 sarus were counted, and the districts with the highest encounter rates were Mainpuri and Etawah in Uttar Pradesh. The distribution range of the sarus crane in India has been drawn. The sarus crane population in India was seen to have an overall low percentage of breeding pairs in the population, and few juveniles, suggesting low recruitment. Factors significantly affecting the breeding are discussed. The cranes were seen to breed practically throughout the year, with two major peaks in February-March and July-August. Changes in land use patterns are presumed to affect habitat use by sarus cranes. The attitude of the local people towards the species is not conducive to the conservation of the vagile species. The implications of the above factors on the conservation of the species are discussed.

Introduction

The sarus crane (*Grus antigone*) is the only crane species breeding south of the Himalayas and the only resident crane in India (Ali and Ripley 1980). Although previously widespread in south Asia, recent developmental activities within its range of distribution have reduced the range and the population of the species (Gole 1989, Meine and Archibald 1996). Three extant subspecies are recognised, and all three are known to be distinct in their habitat requirements and have different distribution ranges (Archibald and Meine 1996). The Indian sarus crane (*Grus a. antigone*) is the largest of the three subspecies and is currently found in Pakistan (C. Mirande *in litt.*) and India. It was found in Bangladesh as well, but may have become extinct (Meine and Archibald 1996). The sarus is held in religious regard in India, depicted in epics (Leslie 1998) and has cultural values attributed to it. The habit of pairing for life has given sarus cranes an iconic status in several places and they are zealously protected (Gole 1996). Research on the sarus crane has so far concentrated mostly on local status surveys (Parasharya *et al.* 1989, Singh and

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Khan 1989, Tatu 1999, Vyas 1999a). Information on imprinting, nidification and diet are available (Law 1930, Ali 1958, Ghorpade 1975) and work on certain aspects of breeding ecology and behaviour has been carried out in select localities (Ramachandran and Vijayan 1994, Vyas 1999b). A national survey to determine the distribution and status of the species was carried out in select states (Gole 1989). It is widely believed that sarus crane populations are declining all over India, and several people have expressed concern (e.g. S. Subramaniam *in litt.*).

We present information on the present distribution, aspects of demography, and conservation status of the Indian subspecies (henceforth referred to as sarus crane), based on two surveys carried out in 1998-99 in its historic distribution range. The survey was carried out exactly a decade after the first all-India survey by Gole (1989), and was aimed at identifying changes, if any, in distribution, population characteristics and status of the species in India.

Sarus cranes in India were known to be distributed in the states of Haryana, Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh and a small population from Maharashtra (Archibald and Meine 1996). Anecdotal reports are available from Jammu & Kashmir and Himachal Pradesh, though their present status in these states is not reported (Gole 1996, Grimmett *et al.* 1998). In all the states, the sarus crane has suffered due to changing land use patterns that have degraded the natural landscape, particularly natural wetlands (Meine and Archibald 1996). This may be the main reason behind the apparent decline (Fig. 1) in their distribution range (Murray 1890, Ali and Ripley 1980, Johnsgard 1983, Gole 1989, Archibald and Meine 1996). The sarus crane is presently protected by the Indian Wildlife (Protection) Act 1972 under Schedule IV. It is considered internationally threatened and is proposed to be placed in the 'Endangered' category under criteria A1b,c,d,e by the IUCN. It is also in Appendix II of the CITES convention. The recent Conservation Action Plan by Meine and Archibald (1996) suggests that the species be moved to Category I of the IUCN and Appendix I of the CITES convention.

Study Area

The survey included the states of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Maharashtra. The second author surveyed Rajasthan, Punjab, Gujarat and Maharashtra; the first author surveyed the rest of the states, and both surveyed Himachal Pradesh. Surveys were carried out twice, since sarus crane distribution is known to change with cropping pattern (Archibald and Meine 1996). The first survey was carried out in summer (henceforth referred to as 'summer survey') during May to October 1998. The main crops grown during this season in the survey areas were paddy, sugarcane and soyabean. The second survey was carried out in winter (henceforth referred to as 'winter survey') from December 1998 to March 1999. The main crops grown during this season in the areas surveyed were wheat and mustard. The survey was spread over a year to obtain data on population status of the species and to determine breeding cycles in the sarus crane, since previous observations suggest that it has an asynchronous breeding that differs from place to place, depending on local conditions (Gole 1989, Ramachandran and Vijayan 1994). Jammu & Kashmir, Himachal Pradesh and West Bengal formed the outer fringe of the previously known sarus crane range of distribution (Gole 1996) and the species had not been reported here since Johnsgard (1983).

Material and Methods

A rapid district level survey was carried out in the states mentioned above in two seasons. Jammu & Kashmir, Himachal Pradesh and West

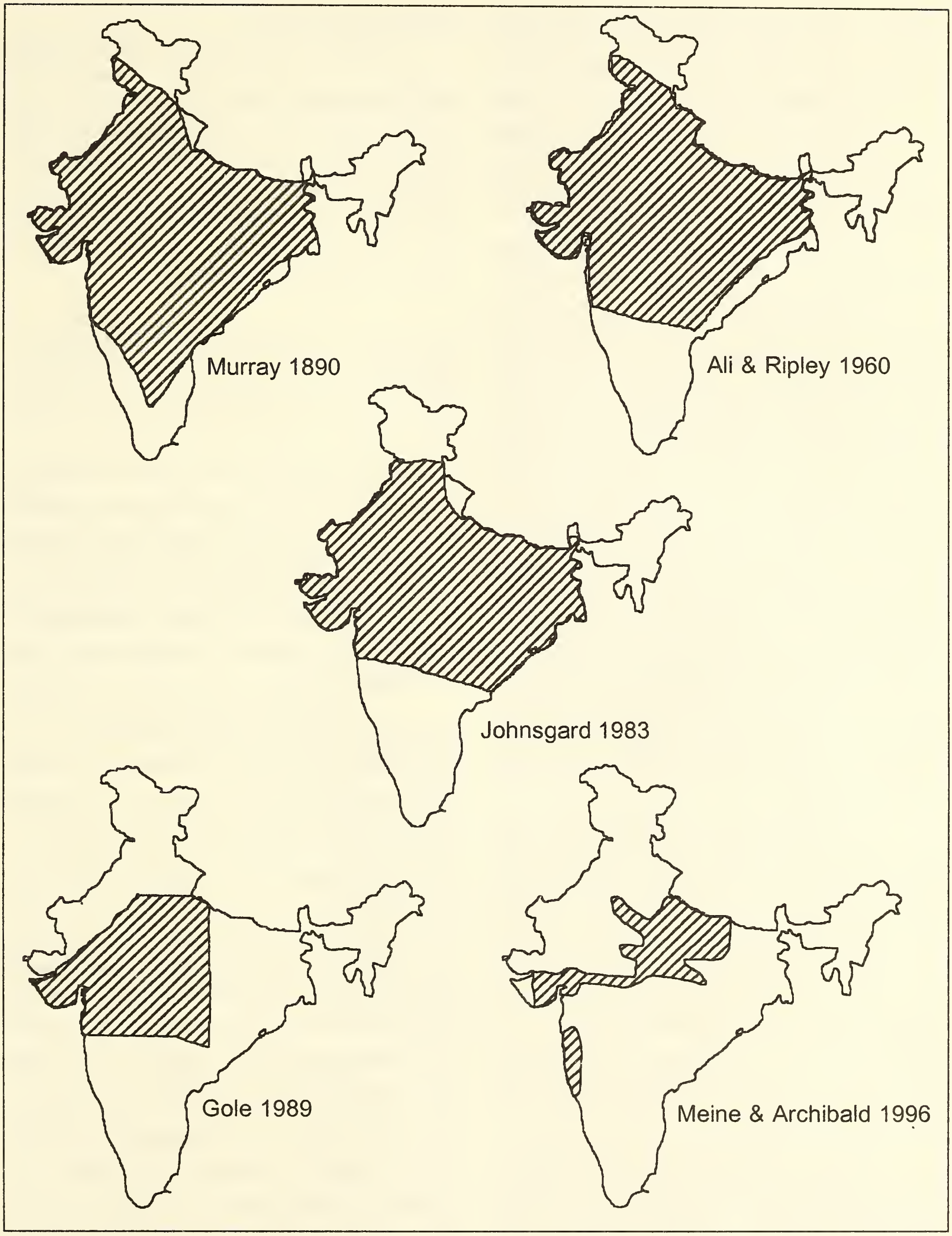


Fig. 1: Shrinking distribution range of sarus crane in India drawn from literature

Bengal were surveyed only in winter, and in two districts each, after secondary information suggested that these states might have a few individuals. Bihar could not be surveyed in winter due to unsteady political conditions. Districts that comprised the historic distribution range were visited to determine the presence, habitat use and status of the sarus.

Two methods were adopted to determine the abundance of sarus cranes in each district:

1. Transects (road or rail routes, referred to as 'road transect' and 'rail transect' respectively) were undertaken on an *ad hoc* basis to ascertain abundance and habitat use patterns by the sarus crane. This consisted of travelling by road on a pre-determined route and counting all the sarus cranes seen on either side of the road. In rail transects, both sides were monitored in some cases, but counts were usually made on one side only. Road transects were undertaken by a motor-bike, jeep or bus, counting sarus cranes seen on both sides of the road in all cases. Locations were recorded, using milestones. A Garmin 12 Global Positioning System was used in winter to record the locations of all sightings. Transects were selected to maximize possibility of sighting sarus cranes, based on published and local information.

2. Wetlands were visited, either while undertaking the transect or independently, chosen to maximize the chance of sarus crane sightings based on available literature and local information. 'Point counts' i.e. counts of all sarus cranes in a wetland and its immediate periphery, were done, using 7 x 50 binoculars from a vantage point. If the wetland was too big to be scanned from one place, the complete circumference was walked and all sarus cranes present were counted.

In addition, locals were shown colour plates of the species, and information on important nesting and roosting sites, foraging grounds, approximate number present in the vicinity, and attitude of the locals towards the species were collected.

If sarus cranes were not sighted, even after a transect was carried out, three wetlands visited and local people interviewed, and the secondary information did not confirm their presence, they were considered absent in the district. Data were analysed separately for the whole range of distribution and for each state. Encounter rates were calculated for all transects undertaken, using the simple relationship:

$$\text{Encounter rate} = \frac{\text{Number of sarus cranes counted on the transect (abundance)}}{\text{Total length of the transect (in km)}}$$

The winter transects and point counts in some districts were the same areas surveyed in the summer. Residential sarus cranes may have been recounted during the second survey.

Demographic parameters calculated were:

i. Percentage breeding population — defined as percentage of sarus crane pairs seen with eggs or young.

ii. Juvenile to adult ratio — chicks, juveniles and subadults (as defined by Ali and Ripley 1980) were clubbed together as 'juveniles' for the analysis, as they were in low numbers when counted separately. 'Recruitment' is defined as the number of juveniles counted.

Definitions of other terms used are indicated below:

'Pairs' were defined as two sarus cranes seen together, presumed to be one male and a female. These were differentiated from 'family', which consisted of a pair with young. 'Groups' were differentiated from 'congregations' based on the number of individuals seen together — 5 to 20 birds together were called 'groups' and any group having more than 20 birds was defined as a 'congregation'. Three or four adults seen together were designated as 'groups', except in cases when it was apparent that one (or two) of the cranes were being tended by the other two

birds; then the former were regarded as offspring of the latter and the group was regarded as a 'family'.

Population estimates were not calculated from the survey results owing to three different methods used in conjunction, variation in time period of survey, and the biased methods of transects and wetland visits.

Results and Discussion

Abundance and encounter rates: The survey covered a total of 11 states, 112 districts and 143 points (transects and wetlands). A total of 1,761 sarus individuals were counted, of which 772 were counted in the summer survey and 989 during the winter survey. Table 1 gives details of the districts surveyed, number of sarus cranes counted, calculated encounter rates, survey method(s), and the major crop(s) being grown in each district. Most of the sarus cranes were encountered in Uttar Pradesh and Rajasthan. In most places, more sarus cranes were encountered during the winter survey. Let us consider each state separately for the discussion.

Jammu & Kashmir: Only two districts were visited, based on secondary information received. A pair of sarus cranes was counted in one district. Information collected indicated that there were three more pairs in the same district. They did not seem to occur elsewhere in the state. The pair encountered was seen to breed by the locals, but no young have been observed. The wetland is very close to the Indo-Pakistan border, and is constantly disturbed by firing from both sides. There are several instances of poaching in the area (A. Rahmani *in litt.*) and the birds are not spared on either side of the border. This species has not been reported from this region since Johnsgard (1983).

Himachal Pradesh: Here also, sarus cranes were seen in one of the two surveyed districts. They have been sighted earlier in the Pong Dam area since 1995 (Lopez and Mundkur 1997 and S. Pandey, *pers. comm.*), and the numbers have increased since. We recorded a juvenile among the seven birds sighted, and the locals confirmed their breeding within the district. In Kulu, we were informed of a pair of sarus cranes that used to reside in the district. One of the pair died of a collision with high-tension power lines and the other was shot by poachers. No sarus cranes have been seen in the district since.

Punjab: Except for a stray record from Hoshiarpur district, obtained as secondary information from locals, there was no sign of the species. Poaching, conversion of natural wetlands to sugarcane and other agricultural fields, and other factors seem to have displaced the species from the state.

Haryana: The state was known to have substantial numbers of the sarus crane (Gole 1989). For the past three years, the state has suffered various degrees of drought, resulting in the drying up of natural wetlands. The few sightings in the state were in protected areas (Bhindawas Wildlife Sanctuary and Sultanpur Bird Sanctuary) where the water level is maintained by a system of canals. Sultanpur Bird Sanctuary used to host populations of up to 80 sarus cranes, several of which used to breed in the sanctuary (R.D. Jakati, *pers. comm.*), which has lost its appeal as a suitable habitat owing to the drought. Information from locals suggested that 10-15 birds are present in Panipat district. A few pairs have been sighted from trains in Palwal district as well, subsequent to the survey period (A. Kumar *in litt.*).

Rajasthan: Most of the 21 districts surveyed had sarus cranes in varying numbers. Seven of them, namely Chittorgarh, Bundi, Kota, Banswara, Bhilwara, Bharatpur and Bara, contributed to 29.81% of the total count of the entire survey. Together, they contributed to 88.84% and 81.42% of sarus cranes counted in the state during summer and winter respectively. Jodhpur, where we failed to record the species,

TABLE 1

SARUS CRANES ABUNDANCE AS COUNTED DURING THE SURVEY AND CALCULATED ENCOUNTER RATES (IN PARENTHESES) IN DIFFERENT DISTRICTS WITH INFORMATION ON SURVEY METHOD(S) AND MAJOR CROP(S) SEEN GROWING, 1998-99.

Sl.	States and Districts covered	Crops grown		Survey method		Abundance (Encounter rate)	
		S	W	S	W	S	W
I	Jammu & Kashmir						
1.	Jammu	*	P	*	1	*	0
2.	Khatuga✱	*	P	*	1	*	2
II	Himachal Pradesh						
1.	Kangra✱	*	Wh	*	2	*	7(0.03)
2.	Kulu	*	Wh	*	2	*	0†
III	Punjab						
1.	Amritsar	P	*	1	*	0	*
2.	Hoshiarpur	P	Wh	1	2	0	0†
3.	Patiala	P	*	1	*	0	*
4.	Ropar	P	*	2	*	0	*
IV	Haryana						
1.	Faridabad	Su	*	2	*	0	*
2.	Gurgaon✱	Su	*	1	*	2	*
3.	Hisar	(Dry)	Wh	2	2	0†	0
4.	Kurukshetra	Wh	Wh	2	2	0	0
5.	Panipat✱	*	Wh	*	2	*	0†
6.	Rohtak	P, Su	*	1	*	3	*
7.	Yamunanagar	O	*	1, 2	*	0	*
V	Rajasthan						
1.	Ajmer✱	P	Wh	1	1	0	10
2.	Alwar✱	P	Wh	1	1	2	6
3.	Banaswara✱	P	Wh	1, 2	2	33(0.1)	33(0.13)
4.	Bara✱	P	Wh	1, 2	1, 2	19(0.19)	28(0.15)
5.	Barmer	*	Wh	*	2	*	0
6.	Bharatpur✱	P	Wh	1, 2	1, 2	21(0.08)	39(0.35)
7.	Bhilwara✱	P	Wh	2	2	16(0.06)	49(0.2)
8.	Bundi✱	P	Wh	1, 2	1, 2	44(0.18)	45(0.18)
9.	Chittorgarh✱	P	Wh	1, 2	1, 2	54(0.2)	79(0.32)
10.	Dausa✱	*	Wh	*	1	*	6
11.	Dhoulpur✱	P		1	1	6	9
12.	Dungarpur	P	*	2	*	0†	*
13.	Jaipur✱	P	Wh	1	1	0	4
14.	Jalor	*	Wh	*	2	*	2(0.02)
15.	Jhalawar✱	P	Wh	1, 2	1, 2	6(0.04)	18(0.09)
16.	Jodhpur	*	M	*	1, 2	*	0†
17.	Kota✱	P	Wh	1, 2	1, 2	37(0.14)	29(0.15)
18.	Pali	P	Wh	2	1	2(0.02)	4
19.	Sawai Madhopur	P	Wh	1	1	2(0.04)	2
20.	Tonk✱	P	Wh	1, 2	1, 2	8(0.08)	7(0.04)
21.	Udaipur	P	*	1	*	2	*
VI	Gujarat						
1.	Ahmedabad✱	P	Wh	1, 2	1, 2	52(0.26)	21(0.1)
2.	Amreli✱	*	Wh	*	1	*	3

TABLE 1 (*contd.*)

SARUS CRANES ABUNDANCE AS COUNTED DURING THE SURVEY AND CALCULATED ENCOUNTER RATES (IN PARENTHESES) IN DIFFERENT DISTRICTS WITH INFORMATION ON SURVEY METHOD(S) AND MAJOR CROP(S) SEEN GROWING, 1998-99.

Sl.	States and Districts covered	Crops grown		Survey method		Abundance (Encounter rate)	
		S	W	S	W	S	W
3.	Banaskantha ✱	*		Wh	1, 2	*	4(0.03)
4.	Bharuch	P	Wh	3	1, 2	0†	2(0.04)
5.	Bhavnagar ✱	P	Wh	1, 2	1, 2	2(0.01)	8(0.08)
6.	Jamnagar	*		*	1, 2	*	4(0.02)
7.	Junagadh	*		*	1	*	8
8.	Kheda ✱	P	Wh	1, 2	1, 2, 3	40(0.2)	58(0.34)
9.	Kutch ✱			1	1,2	4	10(0.05)
10.	Mehsana ✱	P	Wh	1	1	2	33
11.	Panchmahal	*	Wh	*	1		6
12.	Rajkot	P	*	1, 2	*	0	*
13.	Saberkanta	*	Wh	*	1, 2	*	4(0.04)
14.	Surat	P	Wh	3	2	0	0†
15.	Surendranagar ✱	P	Wh	1, 2, 3	1, 2	34(0.34)	26(0.1)
16.	Vadodara ✱	P	Wh	1	1	4	4
VII	Uttar Pradesh						
1.	Agra	(Dry)	*	1, 2	*	0	*
2.	Aligarh ✱	P	Wh	1, 2	1, 2	32(0.21)	42(0.52)
3.	Allahabad	P, Su	Wh, O	2	1, 2	0†	2(0.01)
4.	Azamgarh	Su	*	2	*	0	*
5.	Bahraich	*	Wh	*	1,2	*	4(0.04)
6.	Banda ✱	P	M	2	2	14(0.09)	8(0.06)
7.	Ballia	Su	O	2	1	0	0†
8.	Bareilly ✱	Su, P	Su, Wh	2	2	15(0.29)	5(0.02)
9.	Bijnor	Su	*	2	*	0	*
10.	Deoria	Su	*	2	*	0	*
11.	Etah ✱	P	Wh	1, 2	1, 2	21(0.16)	58(0.58)
12.	Etawah ✱	P	Wh	1, 2	1, 2	61(0.32)	61(0.68)
13.	Faizabad	Su	Wh	1	2	7(0.06)	1(0.01)
14.	Farrukhabad	*	Wh	*	2	*	7(0.08)
15.	Fatehpur ✱	*	M	*	2	*	5(0.07)
16.	Gonda	P, Su	*	3	*	7(0.05)	*
17.	Gorakhpur ✱	Su	Su, M	2	2	0	2(0.01)
18.	Hamirpur	P	*	3	*	2(0.01)	*
19.	Jhansi	(Dry)	*	2, 3	*	0	*
20.	Kanpur	*	M	*	2	*	2(0.01)
21.	Lakhimpur-Kheri	Su, P	M, Su	1, 2	2	0	2(0.08)
22.	Lalitpur	(Dry)	*	2	*	0	*
23.	Maharajganj	P, Su	*	2	*	4(0.07)	*
24.	Mainpuri ✱	P	Wh	1, 2	1, 2	79(1.5)	158(1.3)
25.	Mathura ✱	*	Wh	*	3	*	22(0.21)
26.	Mau	Su	*	2	*	2(0.01)	*
27.	Meerut	Su	*	1, 2	*	0†	*
28.	Mirzapur	*	(Dry)	*	2	*	0
29.	Moradabad	Su	*	2	2	0	*
30.	Pilibhit ✱	Su	Wh	2	2	6(0.16)	19(0.32)
31.	Rae Bareli ✱	P	M	2	1, 2	8(0.06)	0†

TABLE 1 (*contd*)

SARUS CRANES ABUNDANCE AS COUNTED DURING THE SURVEY AND CALCULATED ENCOUNTER RATES (IN PARENTHESES) IN DIFFERENT DISTRICTS WITH INFORMATION ON SURVEY METHOD(S) AND MAJOR CROP(S) SEEN GROWING, 1998-99.

Sl.	States and Districts covered	Crops grown		Survey method		Abundance (Encounter rate)	
		S	W	S	W	S	W
32.	Shahjahanpur	P	M, Su	2	2	10(0.08)	15(0.08)
33.	Siddharthnagar	P	*	2	*	2(0.02)	*
34.	Sirsa	*	M	*	2	*	0
35.	Sitapur✱	P	*	2	*	18(0.15)	*
VIII	Madhya Pradesh						
1.	Bhopal✱	So	Wh	1, 2	1, 2	6(0.06)	0
2.	Damoh	So	Wh	2	2	0†	2(0.02)
3.	Dewas✱	So	*	2	*	0†	*
4.	Dhar	So	*	1, 2	*	0†	*
5.	Guna	So	*	2	*	2(0.03)	*
6.	Gwalior	So	Wh	2	2	0	2(0.03)
7.	Hoshangabad	So	*	1, 2	*	0	*
8.	Indore✱	So	Wh	1, 2	1	64	2(0.03)
9.	Jabalpur	So	*	1, 2	*	0	*
10.	Morena	*	O	*	1	*	0†
11.	Raipur✱	*	Wh	*	1, 2	*	2(0.02)
12.	Raisen	P	Wh	3	2	2(0.06)	0
13.	Ratlam✱	O	*	1, 2	*	0†	*
14.	Rewa	So	M, Su	1, 2	2	0	0
15.	Sagar	So	Wh	1, 2	2	0	2(0.01)
16.	Sehore	So	*	1	*	6(0.07)	*
17.	Shajapur	So	*	2	*	2(0.01)	*
18.	Shivpuri	So	*	2	*	1(0.01)	*
19.	Ujjain	Su, So	*	1	*	0	*
IX	Maharashtra						
1.	Bhandara✱	P	*	1, 2	*	4	*
2.	Chandrapur✱	P	*	1	*	2	*
X	Bihar						
1.	Patna	O	*	2	*	0	*
2.	Motihari	P	*	1	*	0	*
3.	Begusarai	P	*	1	*	0	*
XI	West Bengal						
1.	Cooch Bihar	*	O	*	1, 2	*	0†
2.	Jalpaiguri	*	Wh	*	1, 2	*	0†

S-Summer; W-Winter; Crops: P-Paddy, Wh-Wheat, Su-Sugarcane, So-Soyabean, M-Mustard, Wheat, O-Others

Survey method: 1-Wetland counts, 2-Road transect, 3-Train transect

✱ Districts where sarus cranes were seen breeding with eggs or with young, or places where secondary information indicated that they breed.

* Season when that district was not surveyed.

† Districts where sarus cranes were not encountered during the survey, but information from locals and other secondary information indicated that they are seen in certain areas in the district.

(Note: Encounter rates are calculated only for those districts where the transects were undertaken)

is reputed to have a small non-breeding population during the monsoon. Most districts that were visited, during both seasons (with the exception of Kota and Tonk), had more sarus cranes recorded in winter. Encounter rate was the highest in Chittorgarh district during winter, which was probably due to a bias in the transect route selected. High encounter rates were recorded in Bundi and Kota districts, in comparison with other districts.

Gujarat: A total of 329 sarus cranes were counted. Just three districts, Kheda, Ahmedabad and Surendranagar, had 70.10% of the total count in the state. Of these, the latter two districts recorded a higher abundance in summer. Kutch had a very high encounter rate in winter. Surprisingly, Gole (1989) has not recorded this species from Kutch. Earlier records from the state suggest that populations of the species may have increased only recently, as they used to be "uncommon" previously (Ali 1954: 410). Kheda and Surendranagar districts recorded high encounter rates as well.

Uttar Pradesh: This state had the largest population of sarus cranes among the states surveyed. 73.04% of the total count in Uttar Pradesh were sighted in just four of the 35 districts surveyed namely Mainpuri, Etawah, Etah and Aligarh. Some of the districts were dry when surveyed and had correspondingly low numbers of sarus cranes. Mainpuri and Etawah recorded very high encounter rates, and are the most sarus-populated districts in the country. Etawah recorded an encounter rate of more than one bird per kilometre. In addition to a large number of birds spread out in the fields and small wetlands, certain wetlands in the district are congregation grounds and during the survey, the first author recorded a single congregation of 165 sarus cranes feeding in a dry field with grain stored in it. Etah and Aligarh districts also have very high numbers of these birds, which can be seen even along highways, feeding in roadside ditches.

Madhya Pradesh: The numbers of sarus cranes are generally low, which could be due to the fact that soyabean is the major crop in the state. Most of the sarus cranes counted were in one large flock in the Yashwanth Sagar Reservoir in Indore district. Encounter rates were uniformly low throughout the state. Wetlands in Ujjain district have a few pairs of resident sarus cranes. But the pressure on these wetlands for watering agriculture fields, bathing cattle, and several other domestic activities, is very high. Morena district (National Chambal Sanctuary) in the northern part of the state is reputed to have populations of up to 50 sarus cranes in winter (A.S. Pawar and R. Saxena, *pers. comm.*)

Other States: Maharashtra has a very small pocket of breeding sarus cranes. None were seen in Bihar and West Bengal. In Bihar, an anecdotal report of a pair near the Valmiki Tiger Reserve was the only evidence of the species in the state. In West Bengal, small populations were found visiting remote wetlands in Koochbihar district in winter.

Seasonal difference in abundance and encounter rates: The apparent difference in encounter rates and abundance between summer and winter may be due to the difference in availability of water and food (in the form of crops). In summer, most wetlands dry up, leading to sarus crane congregations in the few available perennial wetlands (as recorded in Indore), while in winter, sarus cranes are more widely spread out in the abundant natural wetlands and wheat fields in which they forage. Thus, surveys may yield higher counts if perennial waterbodies are identified and visited in summer for spot-counts, and transects are best undertaken in winter to calculate encounter rates and densities. Counts in waterbodies are best carried out early in the morning, before the birds disperse to forage, and in the late evenings when most of them have come to roost. This has been tried out successfully in Aligarh district (A. Rahmani *pers. comm.*). Contrary to the hypothesis that sarus crane

distribution range differs between the two seasons, this survey recorded a similar distribution range for the species in both the seasons. Except for the population straying to the eastern fringe of the range in winter, they were recorded everywhere else in both seasons.

A comparison of population estimates from this survey with the data in Gole's (1989) report is unfortunately not possible, due to the different methods used. In addition, encounter rates for this survey have been calculated only for districts actually visited, and are thus not comparable with previous estimates of densities and populations for districts not actually surveyed. From the present survey, estimation of density was not possible. We suggest that results of future studies be presented as raw data, i.e. actual number of birds seen and total number of kilometres covered in transects (or encounter rates) to be helpful for comparison. Such representation of data would prove very helpful to analyze population changes over the years.

Distribution: Fig. 2 shows the distribution range of the sarus crane as projected after the present survey. Two ranges have been drawn on the map:

1. The outermost points known to have sarus crane populations have been connected (straight line) and represent the range of the species as a 'minimum convex polygon'.
2. The dotted line represents the range of the sarus crane as known from information collected from various sources. The international border of India forms the continuation of the dotted line wherever it is incomplete.

The limits of distribution can be defined as follows:

1. Kathua district in Jammu & Kashmir (32° 29' N) forms the northernmost region where sarus cranes are recorded in the country. This is weakly continuous with the populations in Himachal Pradesh, such as in Kangra district.

2. Sarus cranes are well distributed in the *terai* of Uttar Pradesh and their northernmost record in the state was at Meerut (29° 15' N). Another population to the north covered the districts of Hisar, Gurgaon, Rohtak and Panipat in Haryana.

3. Sarus populations were seen in Kutch district of Gujarat (69° 34' N). This forms the westernmost distribution of sarus cranes in the country. The western border extends across Rajasthan, covering Jalor, Pali and Jodhpur districts.

4. Maharashtra is the southernmost state, and Chandrapur district (20° 12' N) the southernmost point of sarus crane distribution. This extends to the northeast into Raipur district of Madhya Pradesh.

5. The easternmost record in the country is by Choudhury (1998) in Assam (95° 35' E). His sightings are seemingly discontinuous with the rest of the distribution range, as no sarus cranes were sighted during this survey in Bihar. The easternmost record in Uttar Pradesh was in Mau (83° 20' E). (Note: Information received from several places in Bihar after the survey suggests that several districts have populations of sarus cranes. Thus, the population is continuous after all, as has been represented in Fig. 2. A complete compilation of reports received subsequent to the survey is being prepared separately.)

Breeding areas: The districts and survey points where sarus cranes were recorded breeding are marked in Table 1 and Fig. 2 respectively. The breeding range does not extend eastwards as much as the distribution range, and its easternmost limit was recorded at Allahabad. The birds were seen breeding throughout the rest of the distribution range in the country.

Demography: *Breeding population*: The percentage of breeding pairs differed between states and seasons. Most breeding pairs were seen in Rajasthan, Gujarat and Uttar Pradesh in that order (Table 2). For the whole population, 19.76% pairs were recorded breeding. Most of the breeding records were made during the winter

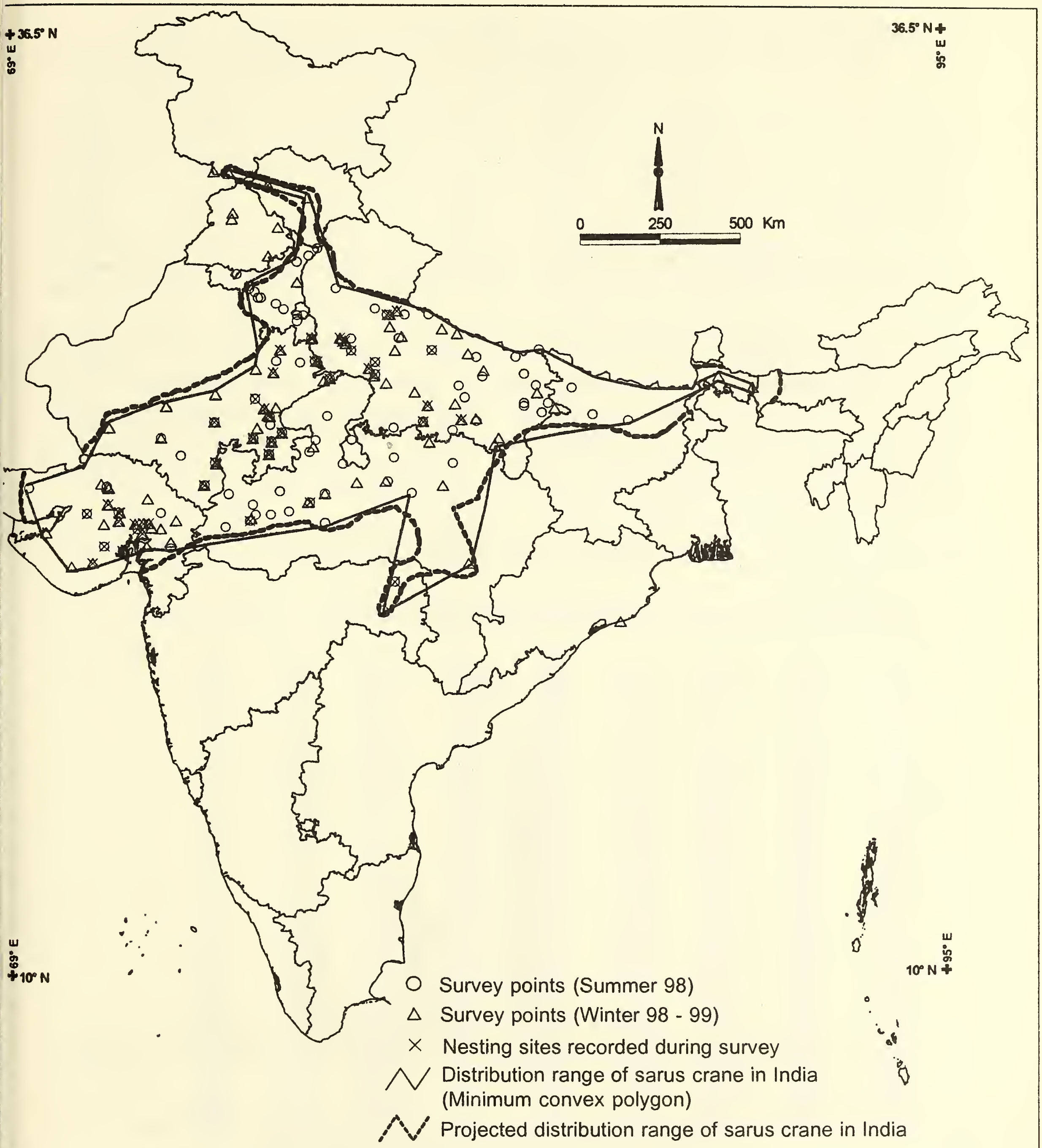


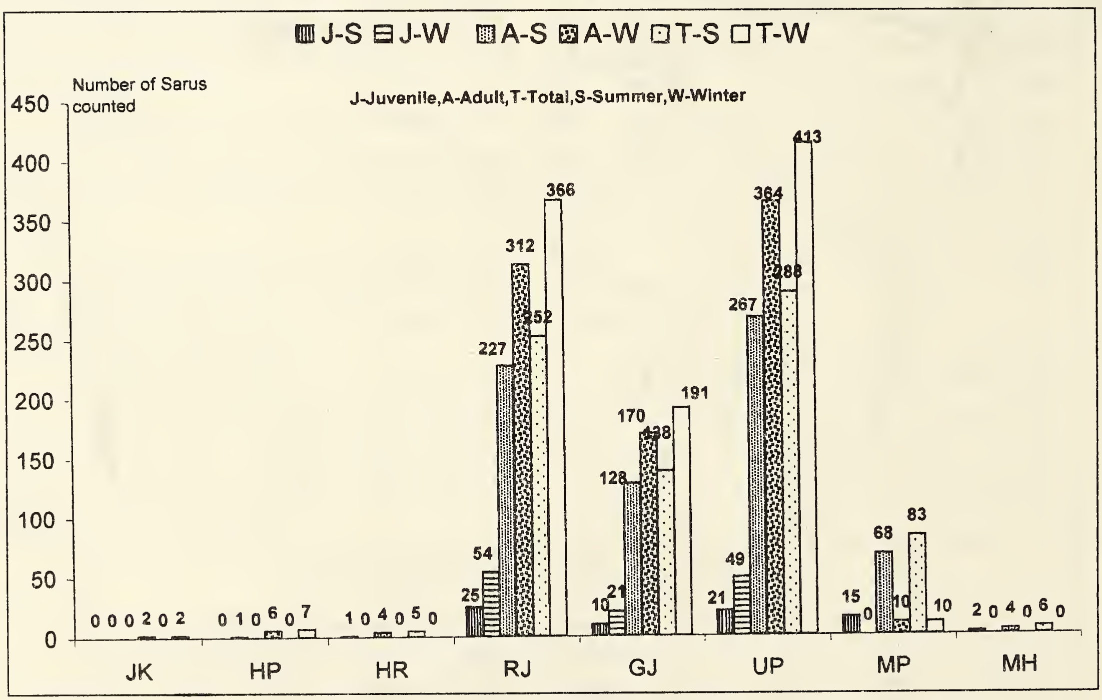
Fig. 2: Present distribution range of sarus crane as estimated from the survey with locations of survey points for the two seasons and observed breeding areas in India

TABLE 2
DEMOGRAPHIC CHARACTERISTICS OF THE SARUS CRANE POPULATION IN DIFFERENT STATES SURVEYED

State	% Breeding Pairs			Juveniles per 100 adults		
	Summer	Winter	Total	Summer	Winter	Total
Rajasthan	18.58	29.03	25	10 (252)	15 (366)	13 (618)
Gujarat	12.5	22.35	18.12	7 (138)	11 (191)	9 (329)
Uttar Pradesh	11.27	27.40	16.88	5 (288)	12 (413)	10 (701)
Madhya Pradesh	10.53	0	9.76	5 (83)	0 (10)	4 (93)
Total	14.49	24.17	19.76	7 (772)	13 (989)	10 (1761)

(Figures in parentheses indicate the total number of cranes considered. Only states where 10 or more sarus were encountered are included in the analysis; other counts are included in calculating total values. Values have been rounded off for the juvenile-adult)

survey (December to March) as recorded previously (Gole 1989, Parasharya *et al.* 1989, Vyas 1999a, Vyas 1999b). Most breeding pairs had one offspring, but a few pairs in select districts had two chicks each. Of the breeding pairs recorded in Gujarat, Rajasthan and Uttar Pradesh, 14.81%, 16.67% and 23.08% respectively had two offsprings each, most of them in winter. This compares well with data on populations of other crane species which fledge two young, such as the whooping crane (*Grus americana*) – 14.5%, Eurasian or common crane (*G. grus*) – 24%, and whitenaped crane (*G. vipio*) – 27% (Johnsgard 1983).



JK - Jammu & Kashmir; HP - Himachal Pradesh; HR - Haryana; RJ - Rajasthan; GJ - Gujarat; UP - Uttar Pradesh; MP - Madhya Pradesh; MH - Maharashtra.
(The same abbreviations hold good for the rest of the figures unless mentioned otherwise).

Fig. 3: State and season-wise sarus crane demography, 1998-99

Juvenile to adult ratio: The sarus crane population had 7 juveniles for every 100 adults in the summer and 10 in the winter (Fig. 3, Table 2). The ratio differed between states and seasons. Rajasthan had the highest recorded ratio of juveniles in winter with 15 juveniles counted for every 100 adults, followed by Uttar Pradesh, which had 12 in winter. The difference in recruitment between localities was because in some localities, pairs are able to rear two young, while in others, only one survives.

Data on recruitment in sandhill cranes (*Grus canadensis*) collected by Miller and Hatfield (1974) show much lower values than those calculated for the sarus crane; 3.5 in 1972 and 4.3 in 1973, for every 100 adult cranes in Saskatchewan, Canada. Ramachandran and Vijayan (1994) recorded a survival rate of 86% in fledglings in Keoladeo Ghana National Park. If this value is consistent among populations in different areas, the majority of the juveniles counted during the survey will survive to adulthood.

Breeding cycle: Most of the breeding was recorded in winter. However, the sarus crane seems to be breeding throughout the year (see Fig. 4 for month-wise breeding data). There were two major 'peaks' observed in the breeding pattern. The minor peak takes place in February-March, with the chicks hatching in March, or rarely, in early June. The second, i.e. the major breeding period starts almost immediately in July-August and continues till September-October, as is indicated by the large number of juveniles seen during this period, and the absence of single adults, implying completion of courtship and pair-bonding (Fig. 4). This observation is in accord with previous studies on local populations, where a minor breeding season (also referred to as sub-season) was observed in February-March

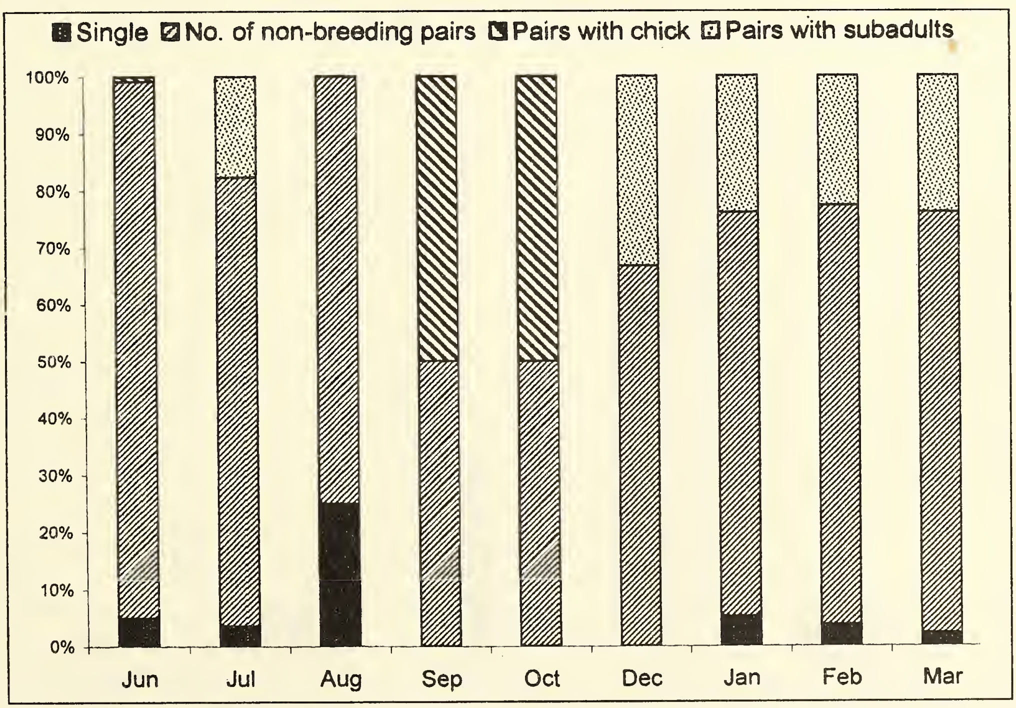


Fig. 4: Month-wise sarus crane demography, 1998-99

in Bharatpur (Ramachandran and Vijayan 1994) and in February-April in Kota (Vyas and Kulshreshta 1989). In these studies, the peak breeding season was observed in August-October and July-October, respectively. Such a bimodal pattern in the breeding leads to the following conjectures: (1) two groups are breeding in the same locality at different times, (2) pairs are breeding twice a year or (3) pairs with breeding failure in one season breed again in the next season in the same year. Long term studies on identified pairs would give insights into this aspect of sarus crane ecology.

Group size: Sarus cranes are characteristically seen in pairs at any time of the year (Fig. 5). Congregations and groups are rare, and a few families can be observed, though mostly in winter. This behaviour is markedly different from the common crane, demoiselle crane (*Anthropoides virgo*) and the blue crane (*A. paradiseus*), which are mostly seen in groups, often numbering tens of thousands, both in their wintering and breeding grounds (Johnsgard 1983, Allan 1995).

Habitat use: Data has been pooled for all age classes and group sizes since there was no marked difference in habitat utilization when assessed separately. In some cases, the data was insufficient to attempt separate analysis. Data on nest sites was not collected, as this was beyond the scope of the project, and warrants different methods. Sarus cranes were seen to use agriculture fields more than other habitat types (Fig. 6). There was a marked increase in the use of natural wetlands in winter, probably because of higher availability of the wetlands after monsoon. A few sarus cranes were seen in artificial wetlands such as bunded tanks, ponds and canals. Sarus cranes forage in shallow water with vegetation along the sides (Gole 1989) and are omnivores, feeding on fish (Law 1930), insects and tubers (Ghorpade 1975) and

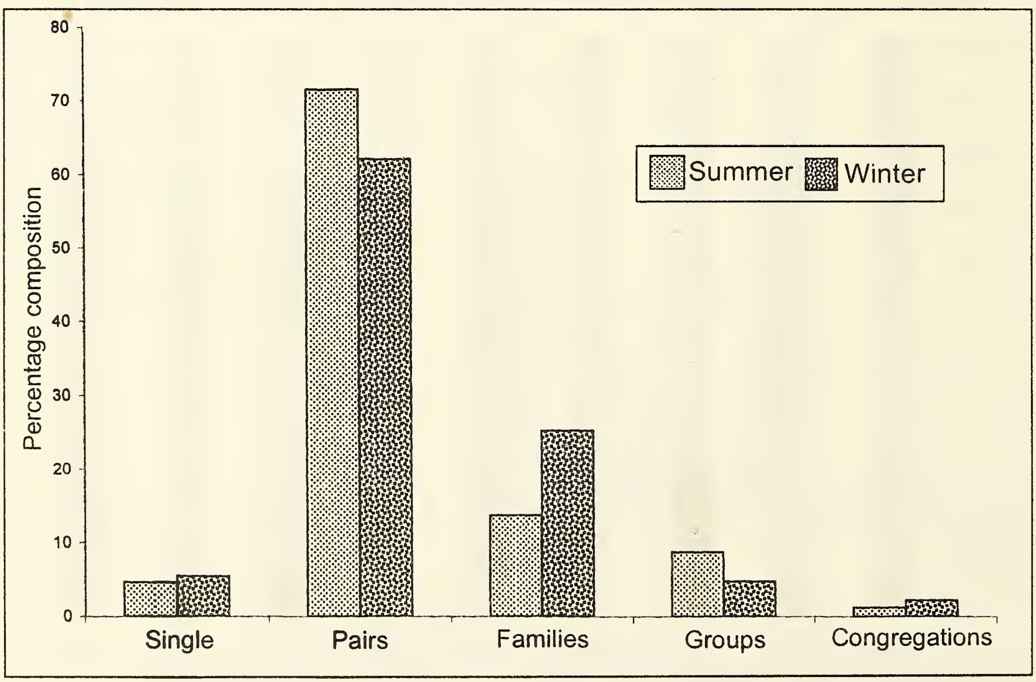


Fig. 5: Group size in sarus cranes

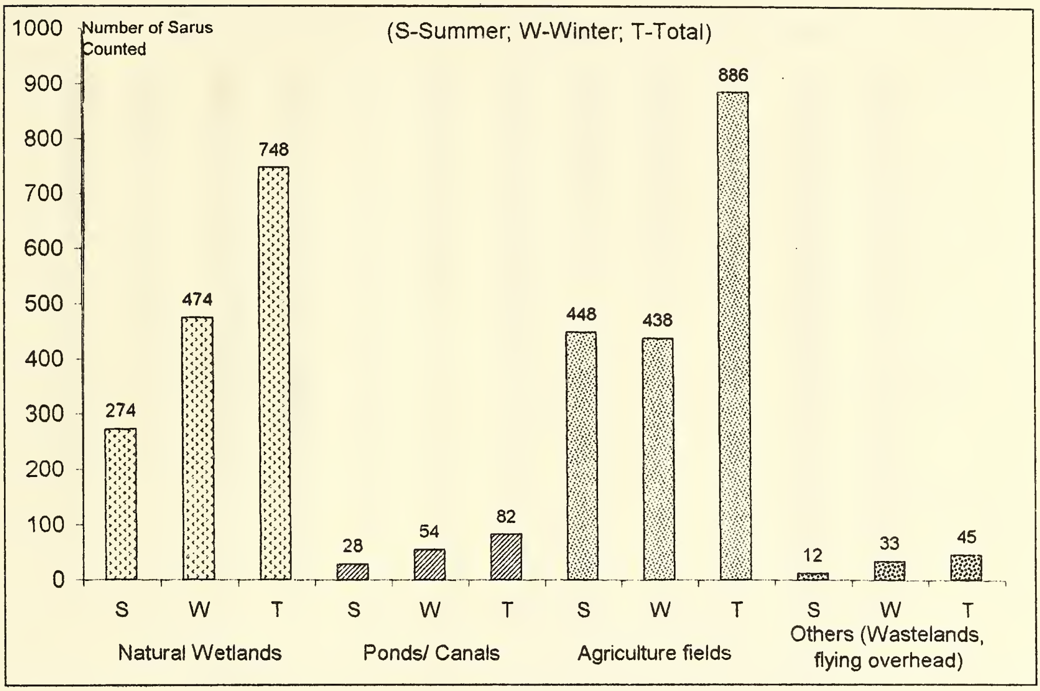


Fig. 6: Habitat use by sarus cranes in India

occasionally on eggs of other birds (Sundar, 2000). Artificial wetlands often have bare, steep sides and deep water at the edges. Natural wetlands, on the contrary, have vegetation on the banks, shallow at the sides and suitable for foraging by water birds, and therefore are preferable for sarus cranes.

Habitats were used differently in different states, presumably due to differential availability. In states with low sarus crane counts, information on differential habitat use is not available. In Jammu & Kashmir and Himachal Pradesh, they were seen in agriculture fields, while in Haryana and Maharashtra, they were seen in natural wetlands. In Uttar Pradesh, most of the sarus cranes were seen in agriculture fields in both seasons (Fig. 7). This could be due to a reduction in the number of natural wetlands and their conversion to agriculture fields (Gole 1989). The sarus cranes are perhaps faithful to the area where they lived. On the contrary, in both Rajasthan and Gujarat, they were found to prefer natural wetlands, and there was a marked increase in the use of natural wetlands in winter.

Among the crop fields, paddy and wheat were used most often in summer and winter respectively (Fig. 8). Sarus cranes eat large amounts of paddy and wheat prior to the harvest of these crops and can become pests (Parasharya *et al.* 1986). They find little to eat in other crop fields such as sugarcane and soyabean. When seen in areas with sugarcane and soyabean, most of the pairs were seen foraging in small puddles at the side of the fields and only one pair was observed preening themselves in the middle of a soyabean field.

All birds were seen in non-forested areas, except for one resident pair seen in a small wetland amid deciduous forested hills, in Dhar district, Madhya Pradesh. In Bandhavgarh Tiger Reserve, Madhya Pradesh, two pairs were reported to breed regularly in the grasslands

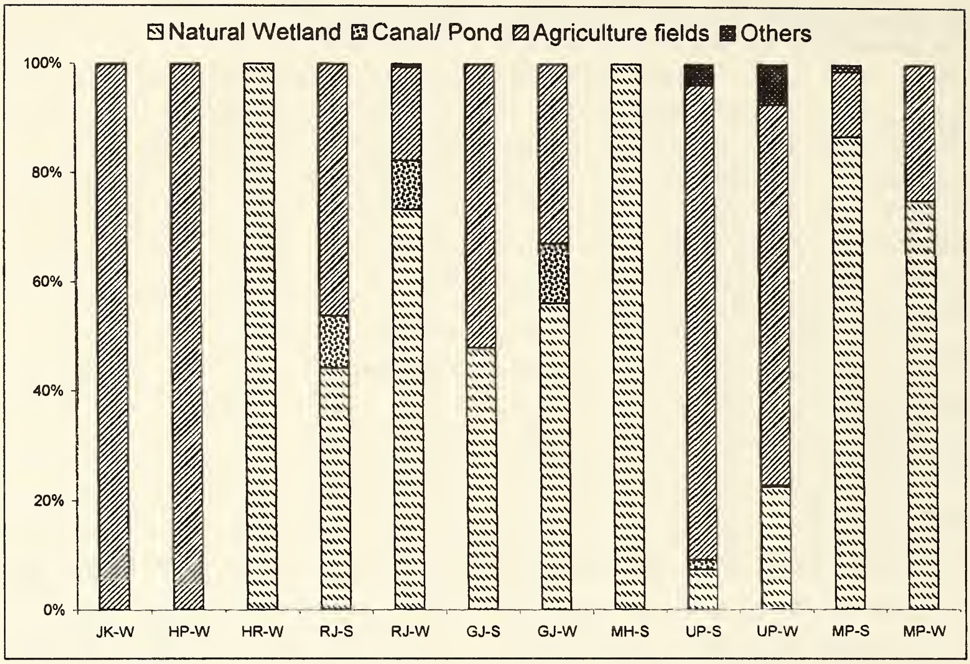
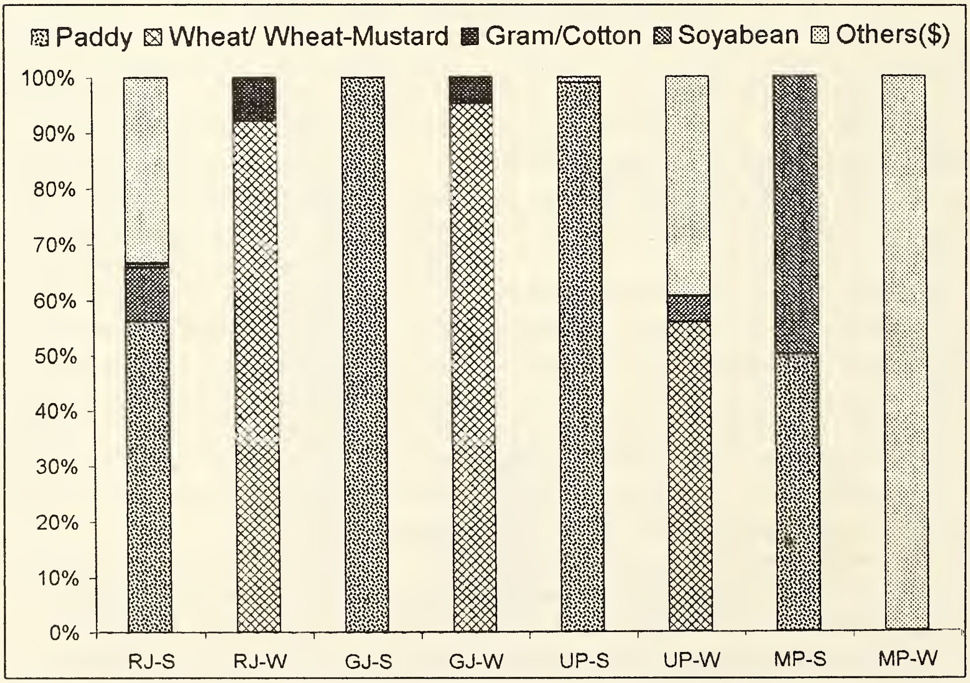


Fig. 7: State-wise habitat use by sarus cranes, 1998-99



$ - Includes inundated, groundnut and vegetable fields

Fig. 8: Crop-land used by sarus cranes in different states (In other states they used only natural wetlands)

amidst the forest. Interestingly, this area in Bandhavgarh was earlier under cultivation (A.K. Mishra, *pers. comm.*) and perhaps the pairs maintain site-fidelity. A similar observation was made in Kanha Tiger Reserve, Mandla district, Madhya Pradesh (Eric D'Cunha *in litt.*). A pair of sarus cranes were seen in the tanks of the Reserve's buffer zone until 1996, but are absent since. This area was previously agricultural as well. One of a pair was shot dead by villagers recently. This disturbance, and the removal of agricultural lands around the tanks would have served to displace the sarus from the area. No information on land use was available for the Dhar area. Non-breeding pairs were occasionally seen in wetlands in Dudhwa National Park, Uttar Pradesh (G. Maheshwaran, *in litt.*).

Three congregations were observed during the survey. Of these, two were recorded in paddy fields (one dry and one inundated), both in Etawah district, Uttar Pradesh. The other was in a reservoir in Indore district, Madhya Pradesh. Another congregation was reported from a natural wetland (riverside) from Banda district, Uttar Pradesh (S.A. Hussain, *pers. comm.*). Such congregations are supposed to be sites for unpaired birds to find partners (V. Prakash and A. Rahmani, *pers. comm.*). Otherwise, the cranes merely congregate to use the few wetlands during the dry months.

Pairs with young typically used open wetlands, natural or artificial (e.g. agriculture fields). The agriculture fields used were always interspersed with natural wetlands, small and/ or large. In areas under sugarcane, pairs with young used the wetlands on the periphery of the fields.

Most crane species around the world select wetlands for breeding, and all species with the exception of the Siberian crane (*Grus leucogeranus*), use drylands as well for foraging (Johnsgard 1983). The blue crane and the demoiselle crane use dryland habitats throughout the year (Johnsgard 1983, Allan 1995). From past studies and the present survey, it is apparent that sarus cranes time their breeding to coincide with a period when food and water is in plenty. This strategy, combined with partial tolerance to changes in the landscape (such as continued use of habitats converted from natural wetlands to paddy fields, but seeming intolerance to sugarcane and soyabean fields), is good for the survival of the species. Other studies have documented the importance of paddy fields for water birds, and the effect of changes in agriculture practices — old practices with minimum disturbance continue to attract water birds (Lane and Fujioka 1998).

Sarus cranes in protected areas: Sarus cranes are vagile (free-flying) creatures, and are rarely contained completely within a protected area. Most of the population spends a great proportion of their time in unprotected, even private land. During the survey, we visited 13 protected areas, most of them bird sanctuaries, and discovered that the population present was negligible, except in certain cases where they seem to owe their survival in that district to the protected areas (Table 4). In Haryana, as mentioned before, the species was seen to be surviving almost completely in protected areas. In Gujarat, one district, namely Mehsana, had the majority of its sarus cranes in protected areas. In other districts, however, most of the individuals counted were in private land. In Uttar Pradesh, except for Rae Bareli, all districts had more sarus cranes in unprotected areas.

Attitude of the local people towards sarus cranes: Most of the sarus population is in private or otherwise unprotected areas, and there is a lot of interaction between the birds and the local people. The data collected by interviewing people in each state revealed that opinions differed from state to state (Fig. 9). In Uttar Pradesh and Maharashtra, there is a predominant feeling that the bird is a pest of crops: feeding on grain, and harming newly sown seedlings by clearing the ground for nesting. Most people in

TABLE 3
DEMOGRAPHIC CHARACTERISTICS OF SARUS CRANE POPULATIONS FROM VARIOUS STUDIES

Source of information and area considered	% Breeding pairs	Juveniles per 100 adults
Parasharya *et al.* (1989) - in Gujarat	42.87	21
Vyas (1999a) - in Rajasthan and a few districts in MP	27	19
Gole (1989) - all India	27.72	14
Present study - all India	19.76	10

(Values have been rounded off for the juvenile-adult ratio)

Madhya Pradesh were neutral to the species and understandably so, since it appears in such low numbers in the state. Also, in one season, the state is carpeted with soyabean, and it is only during the winter wheat harvest that sarus cranes can become pests. Uttar Pradesh, where the maximum number of people were interviewed, was the only state where all individuals knew of the sarus crane.

People who consider the bird as a pest are usually farmers affected by the birds feeding on the harvest in large quantities, and in whose fields the birds clear freshly sown seedlings to make nests. In the former case, they scare the birds away with loud noises or, in some cases, by throwing stones. Where nesting has begun, the farmers remove the eggs from the nests and may eat them, or place them in other sarus nests away from the fields (Parasharya 1998). We did not record any instance of the farmers shooting the birds to keep them away.

From literature (Gole 1989, 1996, Meine and Archibald 1996), it would seem that sarus cranes in India are protected by the locals due to the religious significance attributed to the birds. However, from our survey, 495 of the 1,339

TABLE 4
SARUS CRANE NUMBERS IN PROTECTED AREAS AND TOTAL
NUMBER SEEN IN THE DISTRICT (IF THEY WERE SIGHTED ELSEWHERE)

State		Protected area visited	Sarus cranes counted*	Sarus cranes counted in the district*
I.	Haryana			
1.	Rohtak	Bhindawas Wildlife Sanctuary	3	3
2.	Gurgaon	Sultanpur Bird Sanctuary	2	2
II.	Rajasthan			
1.	Bharatpur	Keoladeo-Ghana National Park	26	56
III.	Gujarat			
1.	Mehsana	Thol Lake Bird Sanctuary	35	35
2.	Ahmedabad	Nalsarovar Bird Sanctuary	17	73
3.	Surendranagar	Tundi Talab (in Wild Ass Sanctuary)	10	54
4.	Bhavnagar	Velavadar National Park	5	8
IV.	Uttar Pradesh			
1.	Meerut	Hastinapur Wildlife Sanctuary	2†	0
2.	Lakhimpur-Kheri	Dudhwa Wildlife Sanctuary	0	2
3.	Agra	Keetham Jheel	0	0
4.	Etah	Patna Bird Sanctuary	20	79
5.	Mainpuri	Saman Bird Sanctuary	16	237
6.	Rae Bareli	Samaspur Bird Sanctuary	15-20†	8

* - Total number of sarus cranes seen in both seasons. Territorial pairs may have been recounted during the second survey.
† - Information provided by local forest staff.

people questioned (37%) regarded the bird as a pest, whereas 501 individuals (37.4%) held the bird in religious esteem. There is not much difference between these percentages, and the sentiments of people could be changing — for the worse.

Mortality in sarus cranes: Breeding pairs were seen to be at risk of colliding with high-tension power lines. Pairs breeding in natural wetlands and agriculture fields fly in and out of the nesting sites and occasionally collide with the overhead wires. Observations in Mainpuri and Etawah suggest that, of the resident population, the cranes affected in this manner could be between 2.5% and 20% respectively (Sundar and Choudhury in press).

No case of mortality was observed in juvenile birds. Their habit of crossing the road could result in the death of individuals, as reported by Parasharya *et al.* (1989). However, no data is available on this form of mortality, which seems to be rare. Egg stealing was observed in practically the entire range of distribution. Eggs are taken for food, and medicine (to treat eye ailments and diseases in cattle; also reported by Tatu 1999). Egg stealing could be the most important reason for the observed low recruitment in the species. In certain areas such as Chandrapur in Maharashtra, and Bandhavgarh Tiger Reserve in Madhya Pradesh, removal of eggs from the few breeding pairs can result in total breeding failure for the entire population. This can be a cause for concern in areas like Kota (Rajasthan), where the population is highly localised, and there is a high incidence of egg removal (A. Nair, *pers. comm.*).

From the available data on demographic factors of sarus cranes (Table 3), the percentage of breeding pairs and recruitment observed

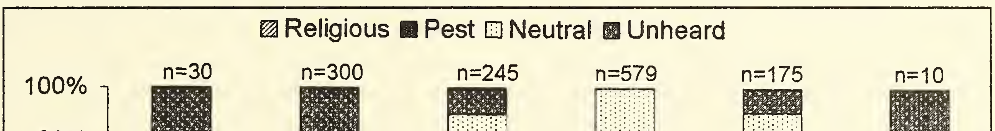


Fig. 9: Opinion of people on sarus cranes in different states*
(* - Only states where at least 10 people were interviewed are included)

during this survey is the lowest. There could be several reasons for this:

1. Breeding incidence has reduced due to decrease of preferred breeding habitat (see Gole 1989, Archibald and Meine 1996).

2. Egg mortality has increased due to stealing by locals.

3. In previous studies, demographic factors were calculated from data for winter surveys, when incidence of breeding is higher.

Implications for conservation: Sarus cranes have a low breeding population and seemingly low recruitment. This makes them vulnerable, and local populations can easily be decimated by removal of select wetlands that the birds use for breeding. Regular surveys have to be carried out to keep a check on breeding grounds and to incorporate protection measures in their management. The importance of maintaining natural wetlands, which are undoubtedly superior habitats for sarus crane breeding and foraging, cannot be overemphasized. However, in the context of India, which is primarily an agricultural country, it may be difficult to develop and maintain large tracts of purely natural wetlands. In this light, the utility of a mosaic of small natural wetlands, interspersed within agriculture fields, can be suitable surrogates to natural wetlands. Mechanisation in agriculture practices will be deleterious for populations in agriculture fields. Prevention of egg stealing, minimum disturbance to nesting pairs and families with young, is important to ensure maximum breeding success. The increasing apathy of locals towards the crane may prove deleterious for its survival. Conservation plans should include protocols by which the locals can be educated on the importance of sarus cranes, and should emphasize the importance of local participation in the effort. Of particular and urgent need is baseline data on several aspects of the ecology of sarus cranes. Important among these is detailed information on breeding requirements, habitat use and selection, patterns of local migration, and behavioural ecology of the species.

Acknowledgements

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LIVESTOCK DEPREDATION BY WOLVES IN THE GREAT INDIAN BUSTARD SANCTUARY, NANNAJ (MAHARASHTRA), INDIA[1]

Satish Kumar[3] and Asad R. Rahmani[2]

(*With three text-figures*)

Key words: *Antilope cervicapra*, blackbuck, *Canis lupus pallipes*, Indian wolf, depredation, pack size, livestock

Food habits of the Indian wolf (*Canis lupus pallipes*) were studied in the Great Indian Bustard Sanctuary, Nannaj, India, between 1991-1994. Estimation of wolf depredation on livestock is essential to implement compensation, management, and conservation plans for the wolf. Blackbuck (*Antilope cervicapra*) was the primary prey of wolves in the Sanctuary; goats and sheep were the major livestock taken by wolves. Data on livestock killed, age of the kill, distance of the kill from the Sanctuary, and the terrain where the kill was made were collected. More goats than sheep were killed, and livestock depredations were higher during the pup-rearing period of wolves, when pups were dependent on parents and/or helpers for food. Multiple attacks were made by wolves on livestock herds to divert the attention of guard dogs. Sixty-three percent of the kills were 1-4 m from a bush or some other vegetative cover. The maximum number of kills (52%) made during daytime were found up to 0.2 km from the Sanctuary plots. The owners retrieved 16% of the total livestock kills, by chasing the wolves or with the help of guard dogs. Mauled animals rarely survived. All the kills occurred in the grazing lands outside the Sanctuary, but kills were carried into the core areas of the Sanctuary. There was a monthly variation in the abundance of goats and sheep in the study area.

Introduction

The Indian wolf (*Canis lupus pallipes*), one of the smallest wolves of the world, represents the southernmost range limit of wolf distribution in the world (12° 57' N and 76° 50' E). The Indian wolf lives in smaller packs, usually 4-7 individuals. It is uncommon, and found in pockets of western, central and peninsular India in open grassland, scrubland, and rocky hills. The Indian wolf is protected by law and classified as endangered under the Indian Wildlife (Protection) Act, 1972. Unlike its temperate cousin, it litters in winter (Kumar 1998).

Compared to other races of wolves, the Indian wolf is unique in the environment in which it lives. Its conspecifics in other regions are attracted to garbage dumps (Mendelssohn 1983a, b) around human settlements and are reported to scavenge goat and sheep carcasses in Saudi Arabia (Iyed A. Nader 1992 *pers. comm.*). This habit is not recorded in the Indian wolf.

The wolf and its principle prey, blackbuck (*Antilope cervicapra*), have responded positively to conservation measures in the Great Indian Bustard (GIB) Sanctuary (Kumar and Rahmani 1997). Wolves exist discontinuously all over the GIB Sanctuary in small packs because of the high human population residing in and around the Sanctuary and consequent disturbance (Kumar and Rahmani 1997). The Sanctuary covers numerous villages, towns, crop fields, grazing land and some pockets of forest land. The major natural prey of the Indian wolf in the GIB Sanctuary is the blackbuck. The blacknaped hare (*Lepus nigricollis*) and rodents are also taken as food. However, the wolf frequently preys on livestock, which brings it into direct conflict with humans. Livestock that fall prey to wolves are

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goats, sheep, calves of cows and buffaloes, pigs, and poultry fowl.

Wolf predation on livestock remains a highly complex and hotly debated issue in India, as depredations cannot be confirmed. Irrelevant claims by shepherds, farmers, and ranchers, differences of opinion over depredation, and exaggeration of the facts only worsens the issue. While conducting this study on the ecology of the Indian wolf in the Great Indian Bustard Sanctuary, Nannaj, we attempted to assess the magnitude of the wolf-man conflict resulting from livestock depredation, estimation of which is essential to implement compensatory payment, planned management, and long-term conservation of the wolf. Our studies on livestock depredation in this part of India were an attempt to answer a few questions on the hunting strategy of wolves, magnitude of wolf-human conflict, and the seasonality of depredation.

Study Area

Nannaj is a small village 20 km north of Solapur between 17° 41' N and 75° 56' E at 486 m above msl (Fig. 1). It lies in the drought prone area of the Deccan Plateau. Due to the rain shadow created by the Western Ghats, the drought prone area of Solapur and its adjacent areas in the Deccan Plateau receive an average rainfall of 750 mm, distributed over 3 to 4 months. The rainfall is erratic and drought is a common phenomenon. The climate of Solapur is semi-arid, with 3 seasons: summer (February to mid-June), monsoon (mid-June to mid-October), and winter (mid-October to January).

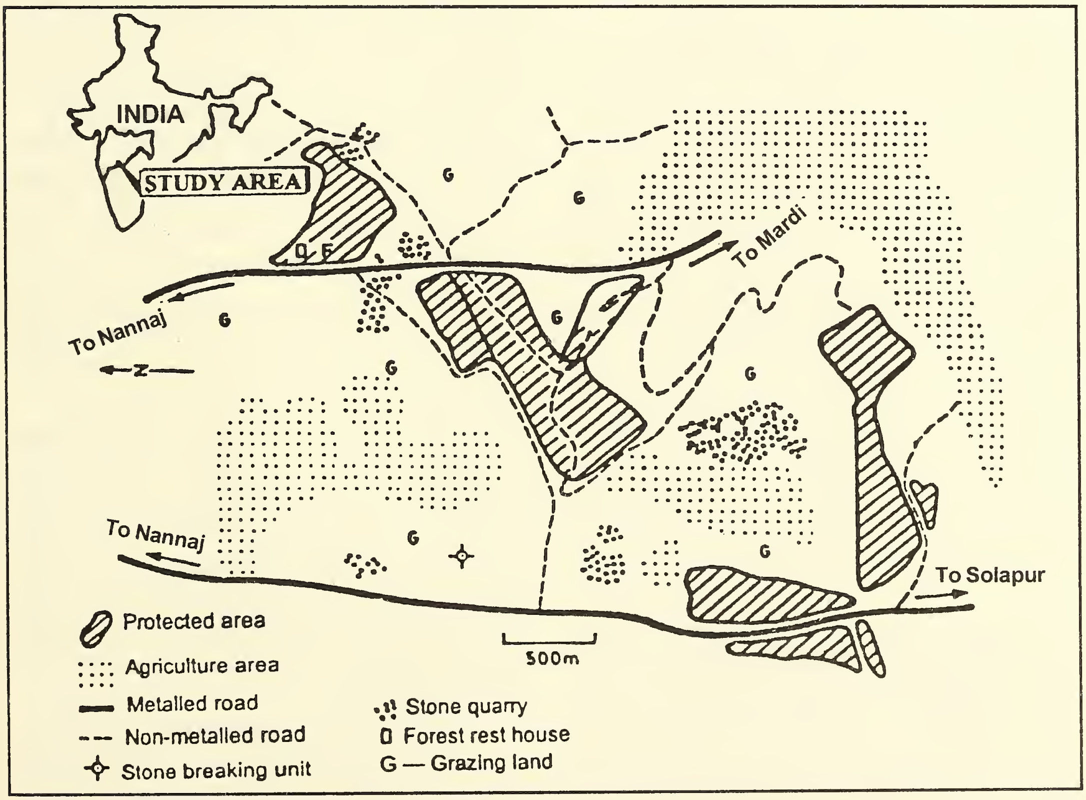

Fig. 1: The Great Indian Bustard Sanctuary, Nannaj, Maharashtra

The monsoon season starts in mid-June or early July with dry spells during late July and early August. There is adequate rainfall in late August and September, which ceases by mid-October. The average temperature varies from 10 °C in December to 45 °C in May. The substratum is comprised of half-decomposed basalt rock formations. The terrain is gently undulating with mild slopes and flat topped hillocks with intermittent shallow valleys, which form the major drainage channels. Grasslands are distributed in disjunct, fragmented patches, forming a mosaic of grazing and agricultural lands and human settlements. Most of the grasslands are present on cultivable slopes and tops of the hillocks. These grasslands are government owned as well as private, and constitute the 'commons' meant for grazing.

In 1975, the Drought Prone Areas Programme (DPAP) financed by the World Bank was initiated in the Solapur district. The DPAP is an area development programme, aimed at integrating efforts in the agricultural and allied sectors to mitigate the adverse effects of drought, by developing land, water, vegetation, livestock and the restoration of ecological balance. The establishment of pastures and plantation plots by the Forest Department under this scheme witnessed resurgence of wildlife. In the early1980s, some plantation plots were established under the District Rural Development Agency (DRDA). The area around Nannaj can be broadly divided into (1) Protected DPAP/ DRDA plots (plantations and grasslands) (2) Unprotected grazing land, and (3) Crop fields.

The protected plots are under the control of the State Forest Department. All DPAP plots are surrounded by grazing or agricultural land. The DPAP plots can be sub-divided into plantation and grassland. Many new plots are coming up in the area under Social Forestry Plantation Schemes.

Methodology

We conducted ecological and behavioural studies on the Indian wolf for three years in an area of 30 sq. km in the GIB Sanctuary, Solapur, between June 1991 and September 1994. One pack (named Nannaj Pack) was observed for detailed behavioural studies. Two other packs, Gangewadi Pack and Mohol Pack were identified around the Sanctuary. The Gangewadi Pack was present 20 km northeast from the centre of the Nannaj Pack territory, whereas Mohol Pack was 25 km west of the Nannaj Pack territory. Data on livestock depredations were collected by ground surveys and also from information given by shepherds and farmers around the Sanctuary. They were encouraged to report any incidence of wolf depredation for further investigation. To estimate losses due to depredations, interviews were conducted during the studies on wolves. Sometimes kills were located opportunistically during ground-surveys for wolf tracks.

First-hand investigation of the livestock depredation claims helped to minimise major biases due to false claims. A complaint was considered authentic if our investigation revealed some evidence such as a wounded animal, remains of the victim, blood stains on grass, wolf tracks, chase sequences on the ground, and signs of struggle. Physical examination of the kill site was done immediately on receiving a report.

The Indian wolf is the only large predator in the study area, hence depredation by other large predators was ruled out. Farmers and shepherd communities informed us about wolf behaviour, particularly its depredation activities at night. The first author (SK) occasionally stayed with shepherds at night to observe wolf activity around villages and confirm the information supplied by them.

On receiving a complaint of depredation, information was collected on the sex and age of the kill, whether the kill was rescued, presence of sheep dogs, and habitat type. The terrain,

vegetation height at the kill site, and nearest vegetative cover from the kill was also recorded. Total count of the livestock was done on a weekly basis around the Sanctuary area to assess its local population. Some elevated spots in the Sanctuary with higher visibility were selected to make counts. The counts were done between 1400 and 1600 hrs, when a maximum number was expected around the Sanctuary. Livestock refers to goats and sheep.

The three wolf denning periods are: (1) December 1991-November 1992 (litter born or raised), (2) December 1992-November 1993 (no litter born), (3) December 1993-November 1994 (litter born).

For some analyses, the denning periods (1) and (3) were further sub-divided into two periods: (a) denning period (pups are dependent on parents and other members of the pack for food; December to May); (b) post-denning period (juveniles start hunting with the parents or independently. This was observed between June and October, after which they start separating and dispersing. Sometimes the pack members were seen in very loose associations).

This was done to test any difference in depredations when (i) the pups were restricted to dens or rendezvous sites, (ii) the juveniles started hunting, and (iii) no breeding took place.

Nonparametric statistical analysis was performed on the data. Differences in predation on goats and sheep were tested by chi-square test. Difference in depredations during the denning period (1) and (2), and between (3) and (2) were tested by Mann-Whitney U test, whereas Kruskal-Wallis one-way analysis of variance was performed when the kills were grouped into three categories. Data collection was completed in August 1994, hence depredations for the year 1993-94 were only for eight months. The pack size of wolves during the study period was not constant; livestock kills were therefore averaged for various comparisons.

Results

The Nannaj wolf pack bred during 1991 and 1993. Pack size varied from 2-7 individuals (excluding pups). No active den was found in 1992; no breeding was observed, probably due to severe drought. During the study period, 101 animals (77 goats and 24 sheep) were attacked by wolves. Of the 16 mauled animals (13 goats and 3 sheep), only 3 goats and one sheep survived. The mauled animals did not die due to infection of wound. All these animals had bites on the neck, muzzle, and head. Of the total kills, the owners retrieved 16% by chasing the wolves or with the help of sheep dogs. Wolves killed twenty goats and sheep at night and the remaining during the day. The night kills (n = 20) were located at 3 km or more from the protected core areas of the Sanctuary.

Of 12 kills during 1991-1992 (monsoon 1991 and winter 1991-1992), maximum depredation occurred in winter (n = 11). This was probably due to the absence of pups with the pack during monsoon 1991 and the presence of five pups during the winter of 1991-1992. During 1992-1993 (summer and monsoon 1992 and winter 1993-1994), maximum kills were found in monsoon (50%) and summer (43%), and the remaining in winter (7%) of 1992-1993 (Table 1), which was probably due to the presence of pups during monsoon and summer, and small pack size during winter when the pack was dissociated and dispersed. During rains, shepherds shelter under trees, while their livestock graze in a wide area, giving wolves ample opportunity to attack the temporarily unguarded herds (Kumar 1998).

No livestock kill was reported in the summer and monsoon of 1993. This was because the shepherds had migrated to other areas where rainfall was higher during a drought year. Some shepherds stayed back with a few herds of livestock that were spread over a wide range. The wolves likewise travelled over a larger area in

TABLE 1
DOMESTIC UNGULATES KILLED BY WOLVES DURING DIFFERENT SEASONS FROM 1991-1994 IN THE GREAT INDIAN BUSTARD SANCTUARY

Seasons	Livestock Depredation Goats	Sheep	Total
Monsoon 1991 (mid-June - mid-October)	0	1	1
Winter 1991-92 (mid-October - January)	10	1	11
Summer 1992 (February - mid-June)	13	6	19
Monsoon 1992 (mid-June - mid-October)	14	8	22
Winter 1992-93 (mid-October - January)	2	1	3
Summer 1993 (February - mid-June)	0	0	0
Monsoon 1993 (mid-June - mid-October)	0	0	0
Winter 1993-94 (mid-October - January)	9	1	10
Summer 1994 (February - mid-June)	24	4	28

search of food. Hence, it is likely that some kills were undetected. The lack of pups (no breeding was observed during 1992-93), and the presence of only two wolves in the territory of the Nannaj Pack in 1993, could also be other reasons for low wolf depredation. Depredation was conspicuous again during the winter of 1993-1994 and summer of 1994. Of the 38 kills, the wolves made 28 (74%) in summer 1994 (Table 1) and the remaining in winter of 1993-94. Maximum depredations occurred in summer 1992 and 1994 and also in monsoon 1992, which was apparently due to the higher demand of growing pups for food. Wolves relied on easy prey at such times, and expended less energy searching for blackbuck. Occasionally, two or more goats were killed by wolves (n = 6) during the same attack. We actually saw wolves hunting and killing goats and sheep six times.

The livestock population of five villages in the GIB Sanctuary namely, Nannaj, Mardi,

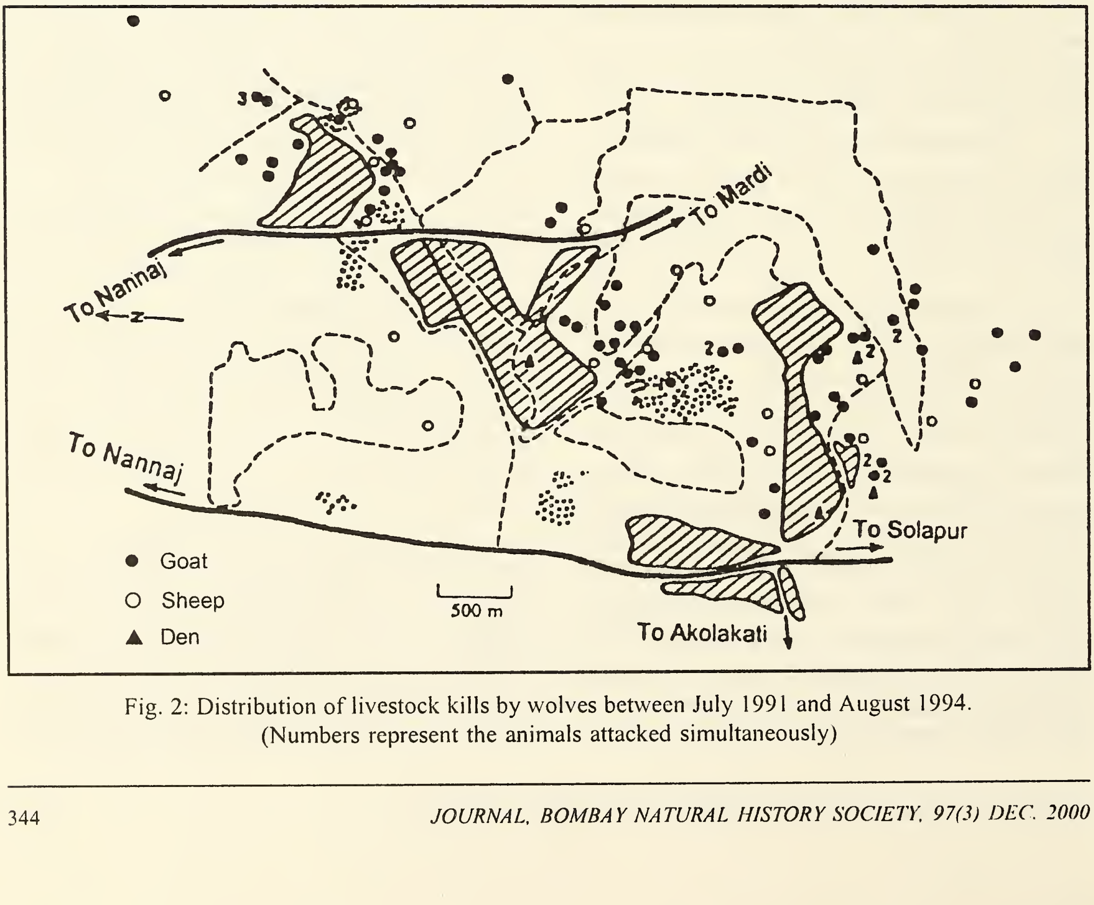

Fig. 2: Distribution of livestock kills by wolves between July 1991 and August 1994.
(Numbers represent the animals attacked simultaneously)

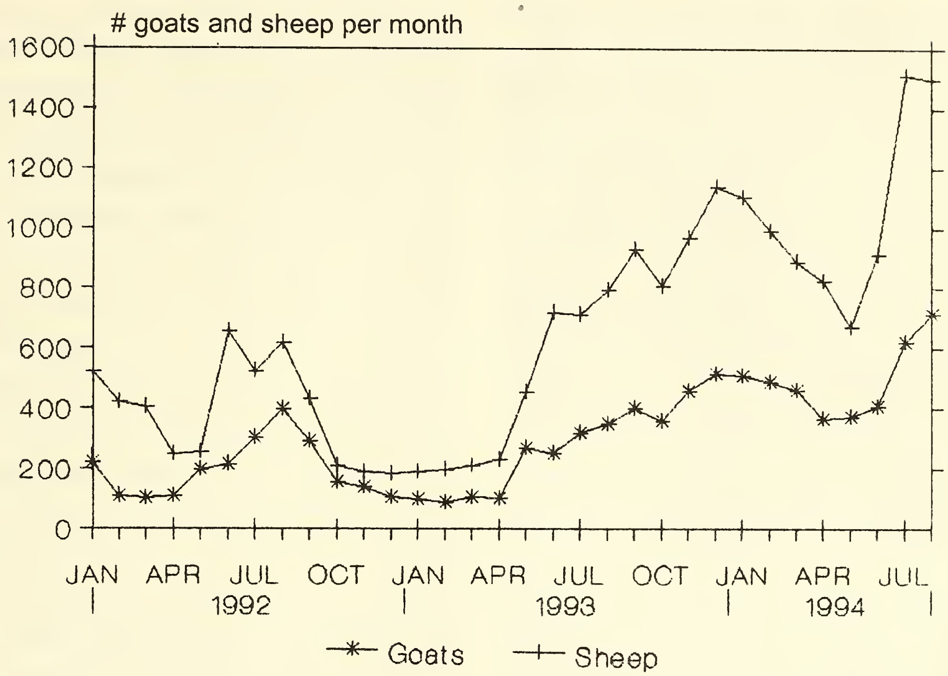

Fig. 3: Monthly variation of goats and sheep in the Sanctuary (numbers are average of weekly counts)

Akolakati, Vadala, and Narotewadi was much higher than the actual numbers grazing in the study area because some grazed outside the study area. Our maximum counts were 743 sheep and 410 goats in 1992, 1,190 sheep and 531 goats in 1993, and 1,706 sheep and 813 goats in 1994 (Fig. 3).

The majority of the kills made during daytime (52%) were found up to 0.2 km from the protected pasture and wood lots of the Sanctuary, probably because the wolves carry the kills into the core areas of the Sanctuary which are undisturbed. Four percent of kills were found at 1 km or more from the Sanctuary. The remaining kills (44%) were found between 0.2-1.2 km from the Sanctuary plots.

The linear distance of diurnal wolf kills of livestock from the protected plots of the Sanctuary (Fig. 2) varied from 0.01 to 1.25 km ($\bar{x}$ = 0.3 km, n = 81). In contrast, the distance of the kills made at night varied from 3.0 to 3.5 km ($\bar{x}$ = 3.2 km, n = 20). Sixty-three percent of the kills were 1-4 m from a bush or some other vegetative cover. Thirty-six percent were 5-12 m from the nearest vegetation, and only 1% kills were 13-15 m from vegetation, implying that most of the victims may have been ambushed by wolves.

Depredations claimed by farmers and shepherds should be interpreted cautiously because of false information. During this study, seven false attacks were reported by locals. Most stated that the wolves entered their livestock corrals on the outskirts of the villages during monsoon, particularly when it was raining. The corrals generally have 1 m high walls which wolves can easily jump over. Slightest laxity on the part of shepherds guarding such livestock confinements gave opportunity to wolf to make a kill. This was confirmed four times by staying with the shepherds. Over a period of time, the wolf must have learned that attacking animals

in a corral during a rainy night was easy, as men and dogs both take shelter.

The wolves killed more goats and sheep during the breeding years 1991-92 (U = 2,631, P < 0.001, Mann-Whitney U Test) and 1993-94 (U = 1,280, P < 0.01, Mann-Whitney U Test) than during the non-breeding year (i.e., 1992-1993). Depredations were higher during the denning period 1991-1992 (H = 48, P < 0.001, Kruskal-Wallis Test) as well as 1993-1994 (H = 14.3, P < 0.01, Kruskal-Wallis Test) when pups were dependent on parents and/or helpers for food, followed by the period when juveniles also start hunting, and the least during non-breeding years.

There was differential predation on goats and sheep. Goats were more susceptible (χ^2 = 14.25, *d.f.* = 1, P < 0.001) to wolf depredation than sheep during the study period (1991-1994) despite higher availability of the latter (Fig. 3). The ratio of goats to sheep counts was 1:2.8. Similarly, there was a difference between the number of goats and sheep killed in 1992 (χ^2 = 8, *d.f.* = 1, P < 0.01) and 1994 (χ^2 = 9.13, *d.f.* = 1, P < 0.005). This may be due to one or more of the following factors: preference of wolves for goats, goats were ambushed by wolves when browsing shrubs and short bushes, and goats were more dispersed as compared to the compact herds of sheep. There was a monthly variation in the abundance of goats and sheep in our study area (Fig. 3).

Discussion

Any damage by wildlife in a developing country like India is a major concern for politicians, agriculturists and wildlife conservationists. Lack of information can lead to controversial decisions on managing a specific wildlife damage problem (Berryman 1984). A comprehensive national policy involving adequate compensation payment to solve wildlife-human conflicts is also hampered due to inadequate information.

The wolf in Maharashtra and in India is not secure, as it lives in the interfaces between agricultural and grazing land. It is poisoned and killed indiscriminately, particularly due to wolf-man conflicts. During March-October 1996, there were reports of 63 children being killed and attacked by wolves in three districts of Uttar Pradesh namely Pratapgarh, Jaunpur and Sultanpur. This resulted in extreme public animosity toward wolves in the entire country. In February-March 1997, five children were killed and five seriously mauled in Rae Bareli, a district adjacent to Pratapgarh and Sultanpur, followed by the killing of another child in Rae Bareli during May-June 1998. Subsequently, three more children were reported to be devoured by wolves in Rae Bareli in July 1999. About 15 wolves were eliminated by police and forest guards deployed in the affected areas during the operation. Owing to such aberrant behaviour of the wolf, coupled with livestock depredations, it is difficult to have public support for wolf conservation in India.

Multiple attack on livestock by wolves appear to divert the attention of sheep dogs. By the time they come to defend one victim, other pack members attack another animal, confusing the dogs. The wolves thus succeed in killing livestock even when they are guarded by dogs.

The wolf population has witnessed some resurgence in the Nannaj area of Solapur after the establishment of the Great Indian Bustard Sanctuary in 1980. The wolves have become visible as harassment by people has been reduced after protection of the area.

The utilization of prey by predators in the nature reserves depends on many circumstances, which change in space and time (Filonov 1980). The Indian wolf has a litter during Dec.- Jan., and the pups leave the den in February or early March. Most of the livestock get killed from December to May. During this time, shepherds try to kill wolves or pups in the dens. The livelihood of the Dhangar tribes which keep goats

and sheep depends entirely on selling these domestic ungulates and their products. They live in the whole of the Sanctuary. Once an active wolf den is located, they fumigate and block the den to kill the pups and sometimes even adults.

The Indian government provides no compensation to farmers for wolf depredation of livestock. Most of the livestock owners-shepherds, Dhangars, and farmers are very poor (average annual income, < Rs. 9,000 [US $ 300]) and loss of even a single goat or sheep is substantial. The farmer and grazier communities suffer on two accounts: their common grazing land is taken under different soil conservation and afforestation schemes, and they lose their livestock to wolves. One of the most important questions to be considered for wolf conservation is the payment of adequate compensation by the government (Sawarkar 1986). Currently in India, compensation payment is made only for the animals killed by tiger (*Panthera tigris tigris*) and lion (*Panthera leo persica*).

Based on our investigations of wolf-livestock conflicts during 1991-1994, the total monetary losses of livestock due to wolves in the GIB Sanctuary, Nannaj were about Rs. 97,380 (US $ 3,246) and Rs. 69,570 (US $ 2,319), if the animals retrieved by graziers are not considered. Livestock depredation is greater in the Sanctuary, because of relatively higher wolf density (4 wolves per 100 sq. km), whereas most of the areas are inhabited by very low wolf numbers (Kumar and Rahmani 1997). A program in the United States which compensates farmers for livestock destroyed by wolves pays an average of US $ 32,170 per year (Paul 1995) for the single state of Minnesota. The program provides compensation as high as $ 400 per animal killed by wolves (Fritts *et al.* 1992).

India is a densely populated country having a thousand million people, yet the wolf is surviving in highly populated areas around settlements, villages and towns. The wolf habitat, unlike that of the tiger, is densely populated, so the problem of livestock depredation is more complex and will remain so in the wolf areas. There seems no easy solution to wolf-human conflict but to reduce the problem by fully or partially compensating the farmers for livestock losses. The compensation after preliminary investigation should be provided with least delay if the wolf is to be preserved in the Sanctuary and some other protected areas in India.

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FEEDING ECOLOGY AND CONSERVATION OF THE GOLDEN LANGUR *TRACHYPITHECUS GEEI* KHAJURIA IN TRIPURA, NORTHEAST INDIA[1]

A.K. Gupta[2] and David J. Chivers[3]

(*With seven text-figures*)

Key words: Golden langur, *Trachypithecus geei*, Tripura, feeding, conservation

Feeding ecology of an introduced group of the golden langur (*Trachypithecus geei*) in Sepahijala Wildlife Sanctuary is discussed with special reference to its conservation in its new habitat. Data were collected using group-scan method. A total of 7,752 scans were made, feeding alone accounting for 3,530 scans (45.5%). Diurnal and seasonal variation in the time spent on feeding was not significant, but a very weak significant difference existed in the time spent on feeding in different months. A total of 53 food species, belonging to 10 families, were used by the golden langur, but only ten species accounted for about 57% of the feeding. Of the 28 families, ten accounted for almost 78% of the food. The three most intensively used food species were: *Ficus racemosa*, *Salmalia malabarica*, and *Adenanthera pavonina*. The golden langur shared food plants with *Trachypithecus phayrei* and *T. pileatus*, and with the local human population. The golden langur was mainly folivorous, spending most time feeding on young leaves (41.4%). The ability of the golden langur to survive on fast-growing exotic plantation species, to use food resources on the ground, and to share resources with other user groups, has helped it to survive in the wild. These qualities make the conservation of the golden langur feasible in its range, where shifting cultivation and plantations of exotic species are common.

Introduction

The golden langur, *Trachypithecus geei* Khajuria, discovered in 1956, is known to occur in India from the Sankosh basin in the west to Manas basin in the east, and from the Assam-Bhutan border foothills in the south, to the inner Himalayan range in the north. Earlier reports on the distribution of this species (Gee 1955, 1961; Khajuria 1956, 1962) describe its occurrence as confined to the Assam-Bhutan border in Jamduar-Raimona area, in Raimona Forest Range, Goalpara district, Assam. This species was first observed in the Bhutan part of Manas Sanctuary by Wayre (1968a, 1968b), and was later described from the Black Mountain Range in Central Bhutan (Mukherjee 1978, Mukherjee *et al.* 1993). Saha (1980) described the actual range of the golden langur only in India (Assam) and Bhutan and concluded that this is a Bhutanese species, and only a marginal part of its range lies within Indian territory between 150 and 3,000 m above msl. On October 6, 1996, members of the Association for Protection of Environment and Endangered Species spotted a few golden langur feeding on bamboo shoots in Sangsak Reserve Forest of Garo Hills, Meghalaya (The Asian Age, November 27, 1996).

Mukherjee and Saha (1974) counted 125 individuals in 13 groups (3 groups from Bhutan — one each from Panjurmane, Tama, and Gaylegphung; and 10 groups from Assam — 7 from Jamduar and 3 from Raimona). Saha (1980) counted about 1,250 in 67 groups from west, central, and east Bhutan provinces. More

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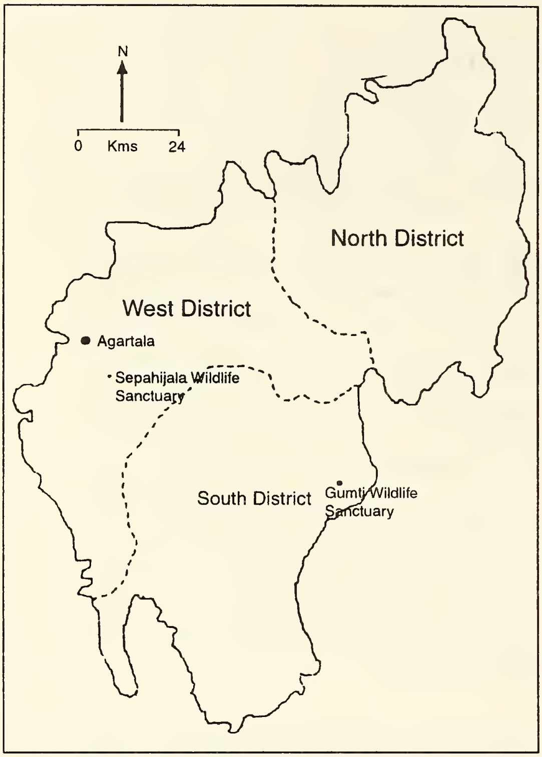

Fig. 1: Map of Tripura showing location of Sepahijala Wildlife Sanctuary

systematic surveys in all northeastern states may reveal a wider range in India. Mukherjee (1981) counted 355 individuals in 34 groups from Goalpara, Kamrup, and Dhubri districts in Assam. Mukherjee (1992) also noted that their number is less on the Indian side between east of Sankosh and west of Manas, and more abundant in the forests of central Bhutan. Wangchuk (1995) sighted a total of 127 individuals along a 39 km transect in Mangde Chu Valley of Central Bhutan, and estimated a population of 4,341 individuals (2.1/sq. km). He also noted the presence of Hanuman langurs in the territories of golden langurs in Tsirang area, and reported the possibility of their interbreeding.

Tripura does not lie in the distribution range of this species. Yet, taking advantage of the favourable habitat conditions, two captive groups of golden langur were released into the wild in 1988: one in Trishna Wildlife Sanctuary, south Tripura, and the other in Sepahijala Wildlife Sanctuary, (SWLS), west Tripura. The golden langur group in SWLS has survived and adapted to the wild (Gupta and Mukherjee 1994), where this species shares the habitat with Phayre's langur (*T. phayrei*), capped langur (*T. pileatus*), rhesus macaque (*Macaca mulatta*), pig-tailed macaque (*M. nemestrina*), and slow loris (*Nycticebus coucang*) (Gupta 1996).

The golden langur is little studied for its distribution status, population estimates, ecology and behaviour. A brief study on its ecology and behaviour was done by Saha and Mukherjee (1974). In this study, a part of the project on Conservation Ecology of Primates and Human Impact in northeast India, a detailed study of the ecology and behaviour of one group of the golden langur and its survival, vis-à-vis other primate species in the study area, especially with reference to two sympatric langur species, has been worked out.

Study Area

The study was conducted in Sepahijala Wildlife Sanctuary (18.53 sq. km), West Tripura, northeast India (Fig. 1). It is located about 35 km south of the capital Agartala and receives an annual rainfall of about 2,000 mm. The mean maximum temperature is 36 °C and mean minimum temperature is 22 °C.

The sanctuary is a small island surrounded by human habitation and agricultural fields. In the past, evergreen forests occupied a large portion of the sanctuary, but following large-scale deforestation, due to human and livestock pressure from 17 adjoining villages, these evergreen forests now exist as scattered degraded patches surrounded by plantations of timber, cash-crops or fast growing exotic species. Some of the oldest plantations in the area (about 50 years old) are those of major timber species such as *Tectona grandis*, *Gmelina arborea*, *Shorea*

robusta, *Dipterocarpus turbinatus,* and *Albizzia procera*.

Methods

Study animal

Khajuria (1960) described the golden langur, and its taxonomy was discussed by Oboussier and Maydell (1959) and Khajuria (1960). This langur is placed with Phayre's and capped langurs in the conservation priority ratings (Endey, 1987), in Schedule I in the Wildlife (Protection) Act, 1972.

Ecological data collection and analysis

After a period of three months, during which the study group of golden langur was habituated and the study area mapped, intensive ecological studies started in December 1993. The group was followed for two consecutive days each month, due to time constraints, from dawn to dusk for an annual cycle of 12 months. Time spent on different activities was estimated by group scans (Altmann 1974). A 'scan' refers to a single recording of the behaviour of an individual within 15 minute intervals, which provided data on feeding. Feeding includes handling, chewing, and ingesting of a food item. Food items were classified as leaf buds, young and mature leaves, flower buds and flowers, unripe and ripe fruit, seeds, and twigs. Whenever possible, food plants were identified. The animal food consumed by the study group was also identified.

Raemaekers and Chivers (1980) have suggested that in a variable and complex forest environment, continual monitoring and frequent sampling of primate groups from dawn to dusk on at least 5, preferably 8-10 consecutive days, is important for assessing the behavioural and ecological repertoire of any primate group. But since the main aim of this study was to collect data on the use of food resources, which were also used by two other sympatric langur species and resident human population, a 2-day observation period could prove sufficient. The data collected from dawn to dusk for 2 continuous days and notes (during surveys, vegetation samplings, phenological studies) provided the first ever systematic data on the behavioural ecology of golden langur, covering all the cyclical changes in vegetation and environmental parameters over a year. Curtin (1980), in an almost similar situation, used alternating periods of 2-3 day dawn-to-dusk observation periods each month for studying the ecology and behaviour of two sympatric species (*Presbytis melalophos* and *Trachypithecus obscurus*).

The percent feeding time during the day was calculated from:

$Tf = (nf \times 100)/N$, where

Tf — % daytime spent on feeding,

nf — number of feeding records and,

N — total number of activity records for the day.

Feeding time on different plant species and parts, as well as animal diets, was also estimated using the above equation (Gupta and Kumar 1994).

Spearman rank-order correlation coefficients were used to analyse the relationships between diet and phenology. The preference index (PI) was calculated for each food species in relation to its abundance in the study area: one divides percentage feeding time on a given species by its relative abundance, calculated as the percentage of total basal area (Kumar 1987). Monthly dietary diversity was calculated using Shannon-Wiener index of diversity (H') (Pielou 1966), using both plant species and parts in the analysis.

Vegetation data collection and analysis

Four plots were established within the study area and 1,090 trees of 112 species, selecting at least 5 trees of more than 20 cm girth at breast height (gbh) from each species. The trees were numbered and measured for their height, gbh, crown width, and crown density.

Each plot was monitored once a month on a predetermined date. It took 2 to 3 days to visit all marked trees over an area of about 60 hectares. Each marked tree was visually scanned for different plant parts: leaf buds, young leaves, mature leaves, flower buds, flowers, unripe fruit, ripe fruit, and seeds. The abundance of a given plant part was recorded as the proportion of total canopy volume using a 0 to 3 scale, referring to the value 0%, 1-10%, 11-50%, and more than 50% respectively (Raemaekers 1977, Bennett 1983, Hardy 1988). Additional information on study animals, study site, and general methods is available in Gupta (1996).

Results

Group Size and Composition

At the beginning of this study in December 1993, there was one group of 7 golden langurs (1 adult male, 3 adult females and 3 infants). In January 1994, one infant was born, but it did not survive. In July, one adult male escaped from the neighbouring Sepahijala Zoo and joined the group. In the same month, it formed a separate group with one adult female from the original group and occupied a different area within SWLS. Observations were continued on the original group, which now consisted of 6 individuals. This group shared the habitat with 17 groups of *T. phayrei*, 18 of *T. pileatus*, 11 of *Macaca nemestrina*, about 37 of *M. mulatta* and 3 groups of *Nycticebus coucang*.

Activity Patterns

A total of 7,752 scans were made on the study group, representing about 304 hours of observations over 24 full days in 12 months with an average of about 646 (sd = 94) scans/month. Feeding accounted for 45.5 % (n = 3,530) of the daytime, followed by resting (26.7%, n = 2,071) and travel (9.5 %, n = 737). Other activities like grooming and play accounted for 18.3% (n = 1,414) (Fig. 2).

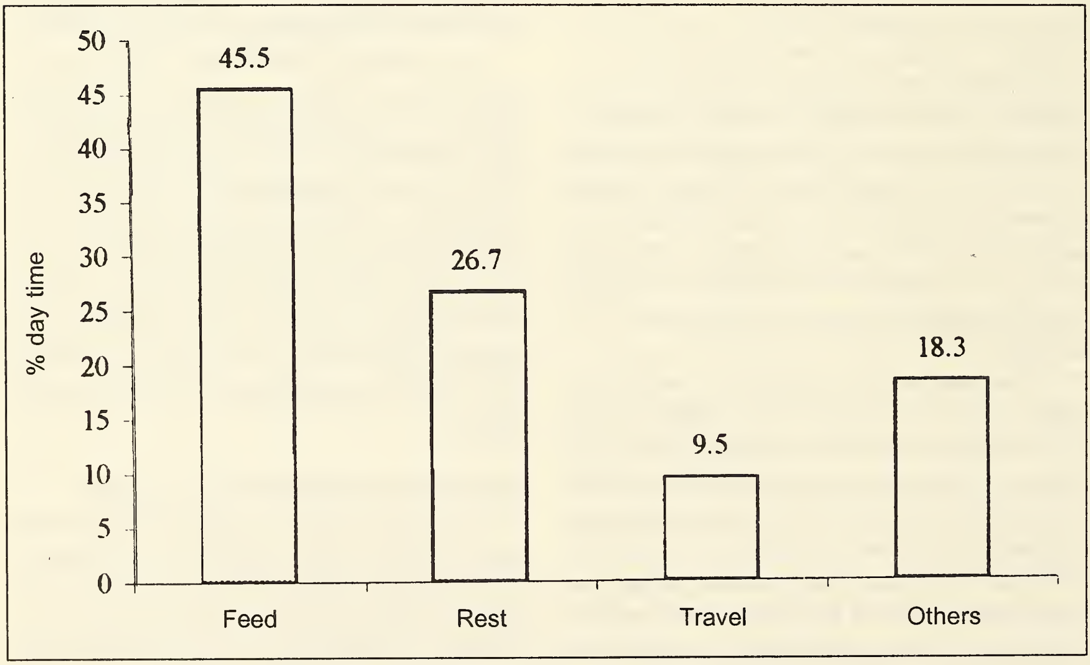

Fig. 2: Time spent (%) in different activities (N=7752)

Feeding

Feeding normally started around 0430 hrs in summer and 0530 hrs in winter. The langurs had two feeding peaks during their 12 to 13 hours of activity in any given day, one peak just after waking up (between 0630 and 0800 hrs), and the second peak in the late afternoon just before roosting (between 1530 and 1700 hrs).

Daily, monthly, and seasonal variations in feeding time

The daily feeding time ranged between 30% (December) and 64.9% (November) (mean = 45.5, sd = 10.1, CV = 22.2%).

A very weak significant difference was found in the feeding time in different months (K-W 1-way Anova, p >0.09), which varied between 36% and 62.6% (mean = 45.6%, sd = 9.4, CV = 20.6%). Most feeding was observed in November (62.6%) and the least in December (36%) (Fig. 3).

The variation in feeding time by the golden langur was not marked when the months were grouped into three seasons: winter (Nov. through Feb.), summer (Mar. through May), and monsoon (Jun. through Oct.). There was no significant difference between the seasons in feeding time (K-W 1-way Anova, p = 0.22) in monsoon months being 49.9%, and in winter months 45.6%. The feeding time in summer months (39.8%) was only weakly significantly different from monsoon months (Mann-Whitney U-Wilcoxon Rank Test, p = 0.07), but not significantly different from winter months (Mann-Whitney U-Wilcoxon Rank Test, p = 0.49). There was no significant difference in the feeding time between winter and monsoon months (Mann-Whitney U-Wilcoxon Rank Test, p = 0.51).

Use of food plant species

A total of 53 plant species were used during the annual feeding cycle by the golden langur. Of these, 45 (84.9%) were trees, 2 (3.8%) shrubs, and 6 (11.3%) were climbers. Of all the food plant species, the majority (N = 42, 79.2%) provided only one type of food item at any given time, while the remaining eleven species (20.8%) provided more than one type of food items at any given time (Table 1).

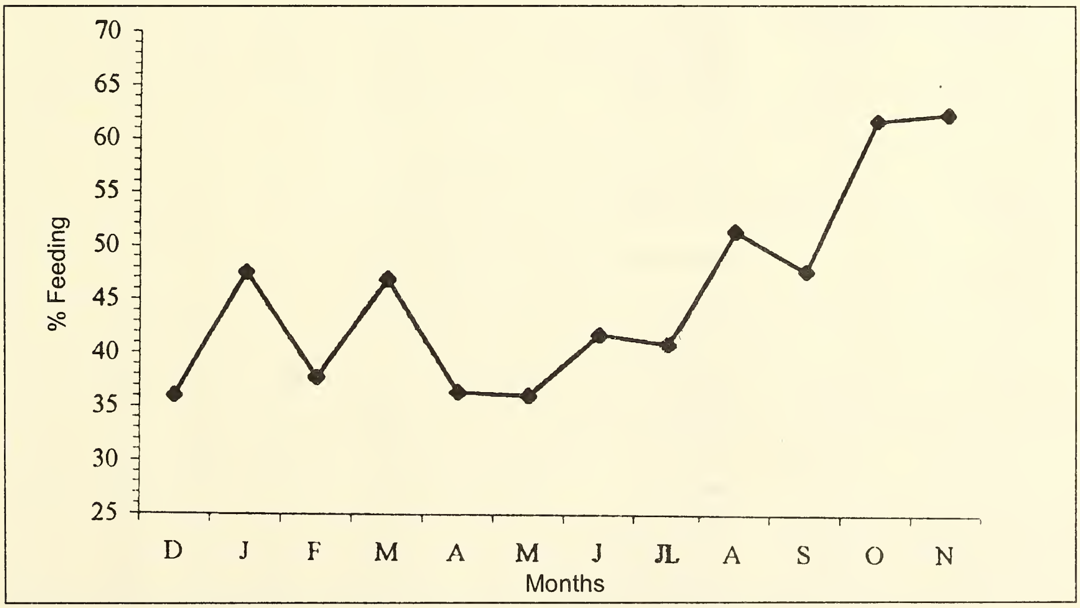

Fig. 3: Monthly variation in time spent feeding by golden langur

TABLE 1
FOOD PLANTS OF THE GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY

Species	Common names	Family	Feeding (N)	% of Total	Parts eaten	E/N	P/NP	FORM
Odina wodier	Kaimala	Anacardiaceae	100	2.8	fb, fl	N	NP	T
Polyalthia longifolia	Deodaru	Annonaceae	3	0.1	yl, ml	N	NP	T
Mikania cordata	Mikania	Asteraceae	208	5.9	yl, fl	E	NP	C
Stereospermum personatum	Soya awal	Bignoniaceae	43	1.2	yl	N	P	T
Salmalia malabarica	Simul	Bombacaceae	122	3.5	yl, fl	N	P	T
Bursera serrata	Neur	Burseraceae	25	0.7	yl	N	P	T
Caesalpinia pulcherrima	Radhachura	Caesalpiniaceae	55	1.6	yl	E	P	T
Delonix regia	Krishnachura	Caesalpiniaceae	430	12.2	yl, fl, s	N	NP	T
Bauhinia malabarica	Kanchan	Caesalpiniaceae	36	1.0	yl	N	NP	T
Terminalia bellirica	Bahera	Combretaceae	64	1.8	urf, twig	N	P	T
Anogeissus acuminata	Kailodi	Combretaceae	32	0.9	pt, yl	N	NP	T
Dillenia indica	Chalta	Dilleniaceae	40	1.1	ml	N	P	T
Dillenia pentagyna	Hargaza	Dilleniaceae	26	0.7	fb, fl	N	NP	T
Dioscorea alata	Maiya-alu	Dioscoreaceae	6	0.2	yl	E	P	C
Pterocarpus dalbergioides	Andaman padauk	Dipterocarpaceae	63	1.8	yl	E	P	T
Mallotus philippensis	Sinduri	Euphorbiaceae	55	1.6	pt, urf	N	P	T
Castanopsis tribuloides	Kanta gach	Fagaceae	17	0.5	s	N	NP	T
Garcinia cowa	Kao	Guttiferae	87	2.5	lml	N	NP	T
Mesua ferrea	Nageshwar	Guttiferae	5	0.1	s	N	P	T
Litsea glutinosa	Kakra	Lauraceae	17	0.5	fb, fl	N	NP	T
Michelia champaca	Champa	Magnoliaceae	9	0.3	yl	N	NP	T
Hibiscus rosa-chinensis	Gurhal	Malvaceae	1	0.0	yl	N	P	S
Acacia auriculiformis	Acacia	Mimosaceae	331	9.4	s	E	P	T
Adenanthera pavonina	Raktanchan	Mimosaceae	123	3.5	yl	E	P	T
Leucaena leucocephala	Kupa	Mimosaceae	98	2.8	yl	E	P	T
Artocarpus chaplasha	Chamal	Moraceae	183	5.2	rf	N	P	T
Ficus racemosa	Vat	Moraceae	174	4.9	ml	N	NP	T
Ficus hispida	Dumbur	Moraceae	125	3.5	urf	N	NP	T
Ficus spp.	Loijuri	Moraceae	71	2.0	urf	N	NP	T
Artocarpus lakoocha	Dewa chamal	Moraceae	61	1.7	rf	N	P	T
**Ficus glomerata*	Jogya dumber	Moraceae	35	1.0	urf	N	NP	T
Ficus religiosa	Pipal	Moraceae	32	0.9	yl	N	NP	T
Syzygium fruticosum	Ban jam	Myrtaceae	46	1.3	sl, yl	N	NP	T
Dalbergia lanceolata	Bhat koroi	Papilionaceae	49	1.4	yl	N	P	T
Ziziphus rugosa	Ban boroi	Rhamnaceae	7	0.2	urf	N	NP	T
Gardenia turgida	Gandhraj	Rubiaceae	11	0.3	fb	E	NP	T

* *Ficus glomerata* is treated as a sub-species of *F. racemosa*

TABLE 1 (*contd*)
FOOD PLANTS OF THE GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY

Species	Common names	Family	Feeding (N)	% of Total	Parts eaten	E/N	P/NP	FORM
Anthocephalus cadamba	Kadam	Rubiaceae	8	0.2	yl	N	P	T
Pterospermum semisagittatum	Banduri	Sterculiaceae	11	0.3	bark	N	NP	T
Aquilaria agallocha	Agar	Thymeliaceae	21	0.6	yl	N	P	T
Microcos paniculata	Pichla	Tiliaceae	28	0.8	rf	N	NP	T
Trema orientalis	Banalya	Ulmaceae	113	3.2	yl	N	NP	T
Trema spp.	Lal banalya	Ulmaceae	8	0.2	ml, lml	N	NP	T
Unidentified	Phul gamar	Unidentified	6	0.2	yl	N	NP	T
Gmelina arborea	Gamar	Verbenaceae	144	4.1	yl	N	P	T
Nyctanthes arbortristis	Rat-ki-rani	Verbenaceae	3	0.1	s, fl	N	P	T
Unidentified climber 4	UIC-4		174	4.9	s	N	NP	C
Unidentified climber 3	UIC-3		112	3.2	fb,fl	N	NP	C
Unidentified climber 1	UIC-1		41	1.2	yl	N	NP	C
Unidentified tree 1	UIT-1		38	1.1	urf	N	NP	T
Unidentified climber 2	UIC-2		14	0.4	s	N	NP	C
Unidentified tree 4	UIT-4		14	0.4	yl	N	NP	T
Unidentified tree 2	UIT-2		3	0.1	yl	N	NP	T
Unidentified tree 3	UIT-3		2	0.1	fb, fl	N	NP	T

sl = sprouting leaf, yl = young leaf, ml = mature leaf, fb = flower buds, fl = flowers, pt = petiole, lml = lamina, s = seeds urf = unripe fruit, rf = ripe fruit.

N = native, E = exotic, P = plantation species, NP = non-plantation species, UN = unknown

Form: T = tree, S = shrub, C = climber

Out of 53 food species, 44 species belonged to 28 families and 9 species could not be identified (Table 1). Leguminosae and Moraceae families accounted for more than half (51.1%) of the total feeding time. Similar to capped langur, the food plants belonging to Leguminosae (together with Mimosaceae, Caesalpiniaceae, and Papilionaceae) were used most (31.8%), followed by Moraceae (19.3%). Eight families (Anacardiaceae, Asteraceae, Bombacaceae, Combretaceae, Dilleniaceae, Guttiferae, Ulmaceae and Verbenaceae) together accounted for about 27% of the total feeding time. The remaining 18 identified and 9 unidentified families accounted for 22% of the total feeding time (Fig. 4). The number of food species belonging to these ten major families varied from 1 (Asteraceae, Anacardiaceae, and Bombacaceae) to 7 (Moraceae and Leguminosae).

Daily, monthly, and seasonal variation in plant species use

The number of food plant species used in each full-day observation was consistent, ranging from 3 to 14 (mean = 9, sd = 2.8). The number of plant species used each month varied from 7 to 18 (mean = 13.5, sd = 3.2), but these variations were very weakly significant (K-W 1-way Anova, $p = 0.1$). The maximum number of food species were used in April (n = 18), and the least in June (n = 7). The total number of plant food species used in three seasons varied between 28 and 42 (mean = 31.6, sd = 3.8).

Use of plant food species between seasons also did not vary significantly (K-W 1-way Anova, $p>0.1$), and was marginally higher in monsoon (64.2%), than in winter (62.3%) and summer (52.8%).

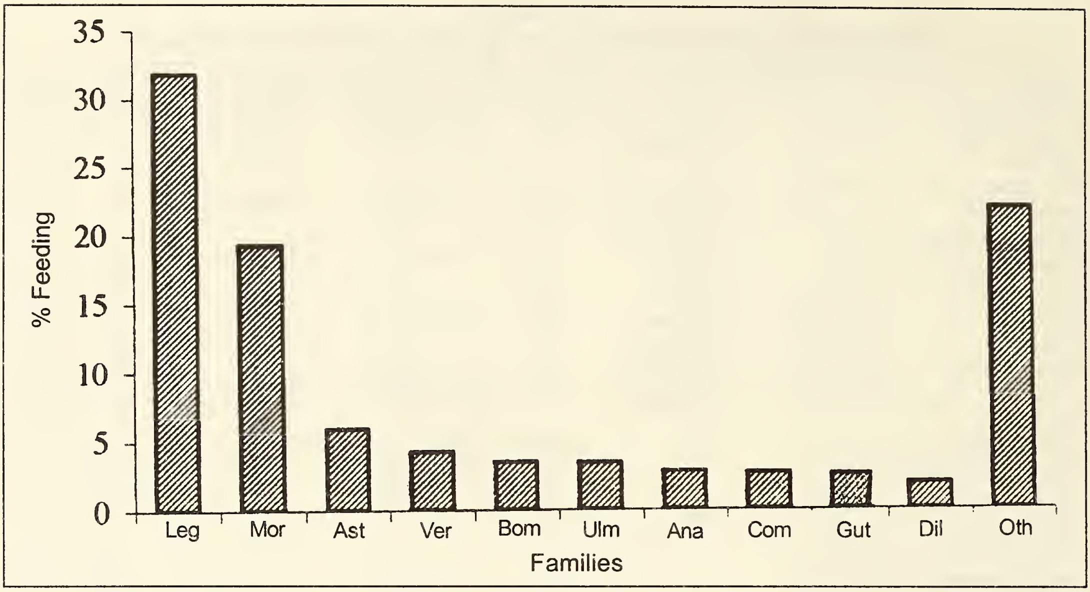

Fig. 4: Time spent feeding on major food plant families and number of species in each family by the golden langur in Tripura

Use of native and exotic plant species

Out of a total of 53 food species, 45 (84.9%), were native plant species (including 9 unidentified species of doubtful identification), and only 8 (15.1 %) were exotic. Unlike the capped langur, the time spent on native food species was higher (74.7%, n = 2,635) than on exotic species (25.3%, n = 895).

Use of plantation and non-plantation species

Twenty-three (43.4%) food species used by golden langur in their annual diet were the common forestry plantation species and the remaining 30 (56.6%), including all 9 unidentified species, were the non-plantation species in the study area. The feeding time on plantation species was slightly less (43.5%, n = 1,536) than on non-plantation species (56.5%, n = 1,994).

Top ten food species

Based on their contribution to the annual diet of golden langurs, the top ten species (*Mikania cordata*, *Acacia auriculiformis*, *Adenanthera pavonina*, *Ficus hispida*, *Delonix regia*, *Salmalia malabarica*, *Ficus racemosa*, *Artocarpus chaplasha*, *Gmelina arborea* and an unidentified climber), accounted for about 57% (n = 2,014) of total feeding time. The monthly feeding time on these species was consistent, and ranged from 20.8% to 85.3% (mean = 55, sd = 18.5, CV = 33.6%). The total number of top ten food species contributing to the diet in any one month varied from a minimum 3 (January, March, and June) to a maximum of 6 (December and July) species. In 9 out of 12 months, these species accounted for more than 50% of the total feeding time on all the species in any given month.

In March and June, only one of the top ten species, the unidentified climber and *Artocarpus chaplasha* respectively, accounted for more 55.8% and 55.2% of the total feeding time. Among the top ten food species, only one species, an unidentified climber, was foraged in one month (March) only, but the remaining 9

TABLE 2
FEEDING TIME (%) ON TOP TEN FOOD SPECIES BY THE GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY

Month	Feeding on top ten species (%)										Total (%)
	AA	DR	MC	SM	FR	FH	AP	UIC	AC	GA	
December 1993	15.0	6.1	11.3	0.8	7.3	12.1	0.0	0.0	0.0	0.0	52.6
January 1994	31.3	0.0	2.3	0.0	17.5	0.0	0.0	0.0	0.0	0.0	51.2
February	3.5	0.0	0.0	0.0	8.3	21.7	0.4	0.0	0.0	0.0	33.9
March	0.0	0.0	0.0	0.0	9.9	2.9	0.0	55.8	0.0	0.0	68 6
April	3.0	5.7	0.0	0.0	4.9	0.0	7.2	0.0	0.0	0.0	20.8
May	1.4	19.4	0.0	0.0	22.3	0.0	9.4	0.0	0.0	0.0	52.5
June	0.0	0.0	0.3	2.3	0.0	0.0	0.0	0.0	5.2	0.0	57.7
July	0.0	8.0	6.2	14.6	0.0	5.8	6.6	0.0	0.0	18.2	59.5
August	0.3	44.9	13.5	0.0	0.0	0.0	2.1	0.0	0.0	4.5	65.3
September	0.0	13.8	5.4	12.1	0.0	0.0	0.0	0.0	1.0	3.4	35.6
October	23.0	26.6	18.9	0.0	0.0	3.9	9.8	0.0	0.0	3.1	85.3
November	21.2	15.5	5.4	10.1	0.0	0.0	7.3	0.0	2.4	15.5	77.4
N	331	430	208	122	174	125	123	174	183	144	2014
%	9.4	12.2	5.9	3.5	4.9	3.5	3.5	4.9	5.2	4.1	57.1
Sd	8.2	11.7	5.3	3.3	5.9	3.9	3.6	4.6	4.9	3.7	55.0
CV(%)	11.3	13.6	6.3	5.5	7.6	6.7	4.1	16.1	15.9	6.4	18.5

AA = *Acacia auriculiformis*, DR = *Delonix regia*, MC = *Mikania cordata*, FR = *Ficus racemosa*, FH = *Ficus hispida*, AP = *Adenanthera pavonina*, UIC = Unidentified climber, AC = *Artocarpus chaplasha*, GA = *Gmelina arborea*

species were foraged during 3 to 8 months (Table 2). *Delonix regia* and *Adenanthera pavonina* were fed upon most (12.2%) and least (3.5%), among all top ten-food species.

Preference Indices

Of these top ten species, 8 were represented in the 12 vegetation transects (*Mikania cordata* and one unidentified climber were excluded from the analysis). Preference indices for each of the 8 (top ten) food species were calculated, based on their relative abundance within the study area, and proportion of total feeding time on the given species. *Gmelina arborea* had the highest preference index (PI) value of 31.5, followed by *Delonix regia* (21.4). Similar to capped langur, *Acacia auriculiformis* was lowest in its PI value (1.2), although feeding time on this species was second (9.4%) only to *Delonix regia* (12.2%). *Ficus racemosa*, *Salmalia malabarica* and *Adenanthera pavonina* were less abundant in the study area, but were highly preferred as food species with relatively high PI values: 10, 6.1, and 5.8 respectively. *Artocarpus chaplasha* was the second most abundant species in the study area, after *Acacia auriculiformis*, but unlike the latter species, *Artocarpus chaplasha* was also highly preferred as food (PI = 8.7) (Table 3).

Out of these top ten food species, three were exotic, accounting for 18.8% of the total feeding time on all species, while 7 were native, accounting for 38.3% of the total feeding time (Table 3).

Five of the top ten species were forestry plantation species in the study area, and accounted for 25.6% of the total feeding time, while the remaining 5 were non-plantation species, accounting for 31.5% of the total feeding time on all species (Table 3).

Six of the top ten species, namely, *Acacia auriculiformis*, *Mikania cordata*, *Delonix regia*, *Ficus racemosa*, *F. hispida*, and *Artocarpus chaplasha* were also among the top ten species used by Phayre's langur. Golden langur shared

TABLE 3
PREFERENCE INDICES OF TOP TEN FOOD SPECIES USED BY GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY, TRIPURA

Species	% Abundance	Feeding		PI	Status	Form
		N	%			
Acacia auriculiformis	8.1	331	9.4	1.2	E	P
Delonix regia	0.6	430	12.2	21.4	N	NP
Salmalia malabarica	0.6	122	5.9	6.1	N	P
Ficus racemosa	0.5	174	5.0	10.0	N	NP
Ficus hispida	2.2	125	3.6	1.6	N	NP
Adenanthera pavonina	0.6	123	3.5	5.8	E	P
Artocarpus chaplasha	6.6	183	5.2	8.7	N	P
Gmelina arborea	0.1	144	1.4	31.5	N	P
Mikania cordata	Not known	208	5.9	-	E	NP
Unidentified climber	Not known	174	5.0	-	N	NP

E = exotic, N = native, P = plantation species, NP = non-plantations species

only five of the top-ten food species (*Acacia auriculiformis*, *Adenanthera pavonina*, *Mikania cordata*, *Delonix regia*, and *Ficus hispida*) with capped langurs in the study area.

Food species used by Phayre's and capped langur groups

Of the 53 food species used by golden langurs 30 (56.6%) were used by the Phayre's langur, while the remaining 23 species (43.4%), were exclusively fed by the golden langur. These common food species accounted for 76.4% of the total feeding time by golden langur and about 67% by Phayre's langur group.

Only 26 (49.1%) food species, out of a total of 53 used by the golden langur, were common with the capped langur. These 26 species accounted for about 75% of the total feeding time on all the food species by golden langur, while their contribution to the feeding time of the capped langur was about 70%.

Food species also used by the local human population

Of the 53 food species used by golden langurs, 23 (43.4%) were also used by the local human population for fuelwood, fodder, small construction timber, timber, food, and so on. The contribution of these 23 species in the annual diet of golden langur was about 48.1 % (n = 1,703).

Use of plant parts

Golden langurs spent most time feeding on young leaves (41.4%), followed by seeds (25.7%), unripe fruit (11.1 %), ripe fruit (10.1%), flowers (9%), mature leaves (2.4%), and others (0. 3 %) (Fig. 5).

The consumption of young leaves was consistently high through all the months compared with other plant parts. Feeding on young leaves was least in March (17.6%) and highest in July (60%). The monthly variation in feeding time was also least for young leaves (CV = 37.9%). There was no significant monthly difference in feeding time on any of the different plant parts.

Only young leaves were eaten in all the 12 months, followed by seeds for 11 months (except in June), and flowers for 9 months. The use of other plant parts ranged between 3 and 6 months.

Time spent eating only flowers was highly significant (K-W 1-way Anova, $p = 0.004$). However, when the monthly data were pooled into three seasons, time spent feeding on flowers was not significant. Seasonal variation in feeding

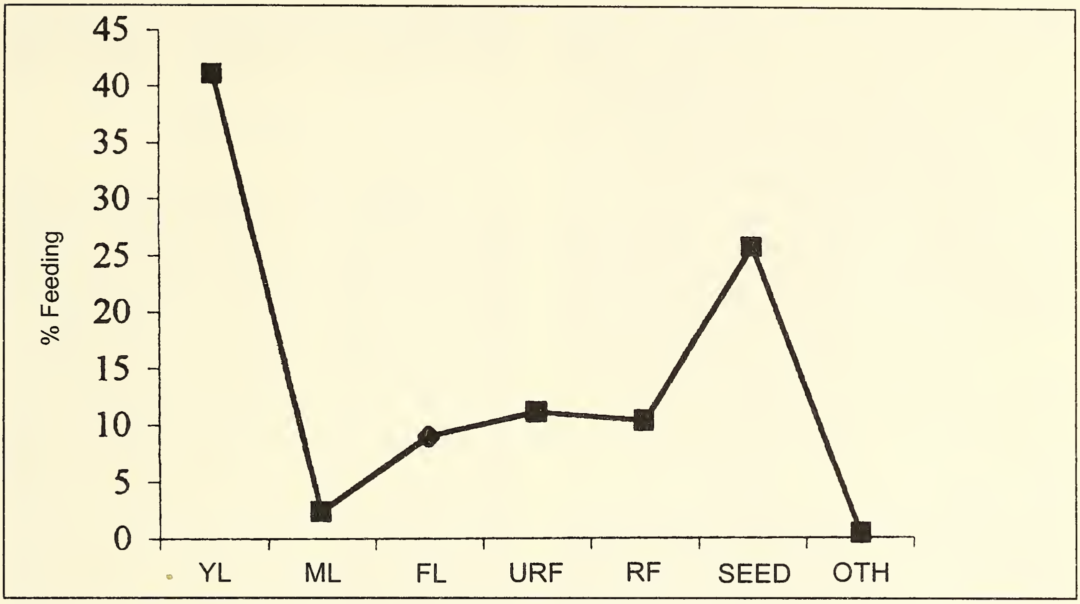

Fig. 5: Time spent feeding on different plant parts by golden langur in Tripura

time on other plant parts was not significant.

Of the 53 food species used by the golden langur group, 40 (75.5%) were for young leaves, followed by 14 (26.4%) for flowers, 10 (18.9%) each for unripe fruit and seeds, 8 (15.1%) for ripe fruits, 3 (5.7%) for mature leaves, and only one (1.9%) for other plant parts (Fig. 6). The total number of species taken in any one month for different plant parts also varied. For the consumption of young leaves, it ranged between 6 and 12 species, but for other plant parts between 1 and 4 only, which was consistent across the months, with most of the food plant species being used for young leaves, and very few for other plant parts

Dillenia indica, *Garcinia cowa* and *Trema* spp. were the three main species used for feeding on mature leaves. One unidentified climber (UIC3) and *Delonix regia* were two main species for flowers. Several species of *Ficus* and unripe pods of many Leguminosae were the main source of unripe fruit. Both *Artocarpus chaplasha* and *A. lakoocha* were the major sources of ripe fruit, besides *Dillenia pentagyna*. *Acacia auriculiformis*, *Delonix regia* and *Adenanthera pavonina* were the major source of seeds in the annual diet of the golden langur group.

Availability of plant parts

The monthly variation in the availability of young and mature leaves, ripe and unripe fruit and seeds are given in Fig. 7. Young leaves, which the group fed on extensively each month, were available for many food plants throughout the year. The food species with young leaves were scarce in the dry months (November through February), when fruit and seeds were abundant. No correlation was found between the feeding time on young leaves in each month and with the number of species with young leaves (Spearman rank correlation coefficient $r_s = 0.14$, $p = 0.67$).

Mature leaves were available mostly during the late monsoon and in winter months, but feeding on mature leaves was only weakly negatively correlated ($r_s = -0.33$, $p = 0.29$) with

their availability. This was because the langurs used only three species (*Dillenia indica*, *Garcinia cowa*, and *Trema* spp.), and the feeding time was dependent on the availability of mature leaves on these three species, irrespective of the availability from other species.

Negative non-significant correlation was found between the feeding time on unripe fruits and seeds and the number of species with these plant parts (r_s = 0.35, p = 0.25; and r_s = 0.33, p = 0.28, respectively). The reason for this is also the dependence of langurs for these food items on only 1 to 3 plant species, irrespective of the availability of these plant parts on other species.

Ripe fruits of *Artocarpus chaplasha* and *A. lakoocha* were available only during the dry months (November through February), but more than 70% of the total feeding time on ripe fruit was only in one month, i.e. June. Therefore, no correlation was found between the availability and feeding time on ripe fruit (r_s = 0.03, p = 0.90).

Discussion

Golden langurs are primarily folivorous, but were able to switch over to a fruit and seed diet when foliage was scarce. Most of the food species were used for young foliage. Other plant parts were consumed from a few food species, most of which were common with the Phayre's and capped langur (*Acacia auriculiformis*, *Adenanthera pavonina*, *Delonix regia*, for seeds, and *D. pentagyna*, *Artocarpus lakoocha*, and *A. chaplasha* for ripe fruit). Although golden langur shared the habitat with two other species, there was some resource partitioning by the use of different food species for specific food items. The primary source for mature leaves (*D. indica*, *Garcinia cowa*) for golden langurs differed from

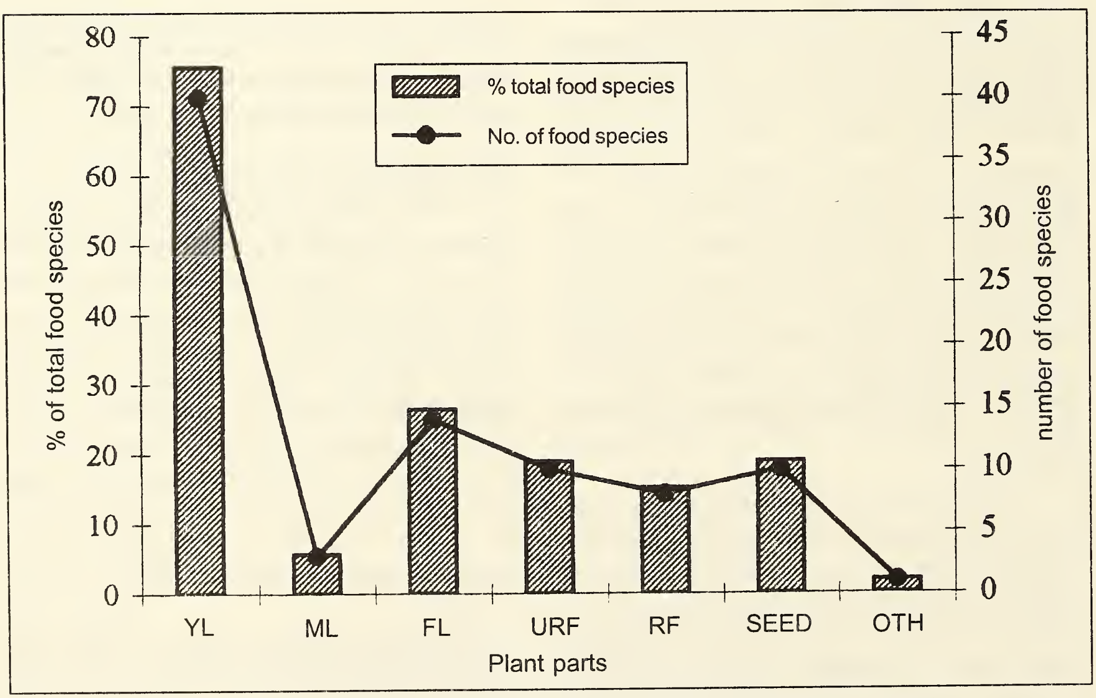

Fig. 6: Number and % of food species used for feeding on different plant parts by the golden langur in Tripura

Phayre's (*Ficus racemosa*) and capped langurs (*Ailanthus integrifolia*, *Pterocarpus dalbergioides*). While several species of *Ficus* were used by golden langurs as primary sources for unripe fruit, other langurs used two species of *Ficus* and *Artocarpus chaplasha* (Phayre's langur) and *Artocarpus heterophyllus* (capped langur). Although primary food sources for ripe fruit and seeds were the same in all three species (*D. pentagyna* for ripe fruit; *A. auriculiformis*, *A. pavonina*, *D. regia* for seeds), on most occasions the three langur species visited the same food patches at different times. Inter-group relations with capped and Phayre's langur were always relaxed, as on occasions the groups shared food trees, approaching within 5 to 10 m of each other, and infants mixing and playing with each other. The tendency of golden langurs to feed on the ground and very close to human habitation also helped them use resources that were not available to the other two sympatric species.

In the use of food plants, golden langurs shared species with Phayre's and capped langurs and the local people. As in Phayre's and capped langur, most of the preferred food species for golden langurs were exotic fast growing plantation species from Leguminosae and Moraceae families.

The ability of golden langurs to survive on a few fast growing exotic plantation species could be used as a main management tool to increasing the existing resource base through plantation of such species. This is likely to benefit other different user groups (local human populations and other wildlife species sharing the habitat), besides the golden langur.

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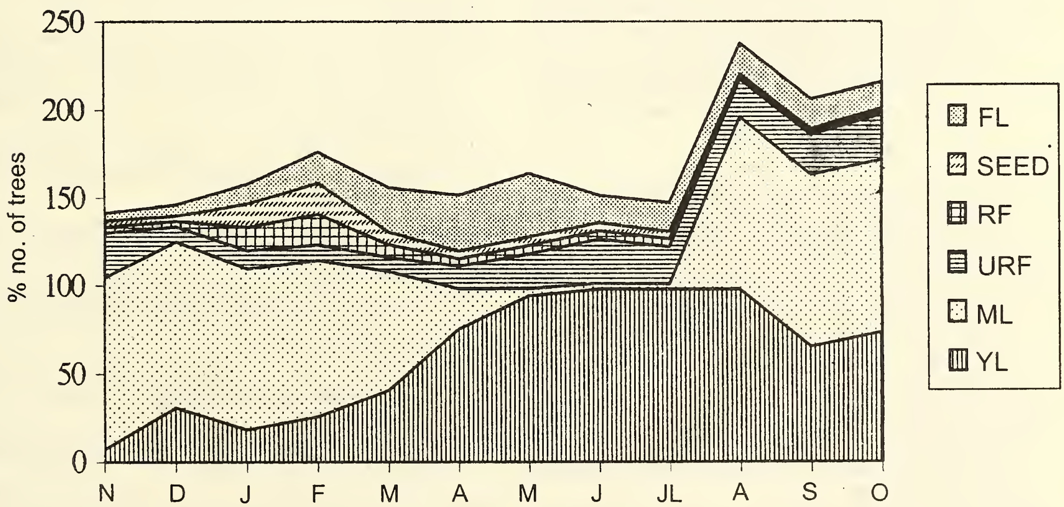

Fig. 7: Monthly variations in the availability of plant parts

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OVIPOSITION BEHAVIOUR OF THREE INTRASPECIFIC VARIANTS OF THE VISCERAL LEISHMANIASIS (KALA-AZAR) VECTOR *PHLEBOTOMUS ARGENTIPES* [1]

K. ILANGO[2]

(*With one text-figure*)

Key words: *Phlebotomus argentipes*, visceral leishmaniasis vector, oviposition behaviour, intraspecific variation

Oviposition behaviour of *Phlebotomus argentipes* Annandale & Brunetti *sensu lato* studied in the visceral leishmaniasis (VL, kala-azar) endemic and non-endemic parts of Tamil Nadu suggests that (i) the species has 3 intraspecific variants (possibly representing separate species), (ii) the mean number of eggs laid per fly is higher in the flies fed on cattle than on human beings, (iii) the variant human-fed form is sympatric with the neighbouring cattle-fed form, while both the cattle fed variants are allopatric in nature, (iv) the possible cause for the vector capacity of the form feeding on humans is discussed, (v) research on the behaviour, based on genetics and using molecular biological tools such as isoenzyme analysis and DNA paw printing, is needed to resolve the taxonomic status of *P. argentipes*.

INTRODUCTION

Phlebotomus argentipes Annandale & Brunetti *sensu lato,* described by Annandale (1908), has been studied extensively as a vector of the Indian visceral leishmaniasis (VL, kala-azar). The currently known geographical and biological variations of *P. argentipes* may consist of a complex of sibling species (Seccombe *et al.* 1993), that are morphologically similar but different in behaviour. Recently, two morphospecies found sympatrically were described from the city of Chennai (=Madras) (Ilango *et al.* 1994), one of the known foci of VL.

Incrimination of vector species among the species complex is extremely important for taxonomists before developing any control strategies. However, the problem among closely allied variants in insect vectors is that competition for resources, such as feeding hosts and mating sites, in similar ecological conditions, leads to divergence of behaviour and formation of two or more species (Dobzhansky *et al.* 1976). This is usually found in disease endemic regions. To differentiate such closely related species, morphological taxonomy serves a limited purpose, but molecular techniques and genetics based behavioural studies are extremely reliable. In view of this, while surveying the wetland mosquito fauna of Tamil Nadu, the oviposition behaviour of *P. argentipes* was studied in parts of the state where kala-azar is endemic.

STUDY AREA

In Tamil Nadu, the city of Chennai and two rural districts, Ramanad and Tirunelveli, known endemic foci of VL, were surveyed for the phlebotomine sandfly fauna during 1987-90. Recently, a few cases of kala-azar were reported from Chennai, but the disease was unknown in the Ramanad and Tirunelveli district. Chennai was, therefore, considered an endemic focus, while Ramanad and Tirunelveli were designated as non-endemic. For the present study, Tirunelveli (peridomestic) and Chennai (domestic and peridomestic) were chosen for

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sample collection because they are widely separated from one another, and represent different habitats. Further, in Chennai, samples were collected from the centre of the city, Royapettah (domestic) where VL was known to exist, and from the suburban village Poonamalle, 30 km west of Chennai, from where VL was not known.

Method

Veeravandiyur village in Tirunelveli district and Poonamalle village near Chennai are identical habitats in their housing pattern, surrounded by cattle sheds, paddy fields and irrigation ponds. Royapettah has typical urban dwellings with crowded housing. Stray cattle were often found on the streets. Humans and cattle are the sources of blood meal for *P. argentipes* prior to oviposition.

As *P. argentipes* is nocturnal, night collection of samples was made from both human dwellings and cattle sheds. In all the 3 study sites, blood-fed females were collected from the abdomen of cattle in Veeravandiyur and Poonamalle villages, humans also served as bait simultaneously. Blood-fed flies were individually stored in ½" x 3" glass tubes and left undisturbed overnight to oviposit. 5% glucose solution soaked in cotton was supplied to each fly as nutritional supplement.

Results

Fig. 1 shows the locations (ABC) from which the females of *P. argentipes* were collected; the bar diagrams represent the mean no. of eggs laid per fly. The distance between Veeravandiyur (A) and Royapettah (B) or Poonamalle (C) is 680 km and Royapettah (B) and Poonamalle (C) 30 km. In Veeravandiyur and Poonamalle villages, the female flies showed a greater preference for cattle than for human beings, whereas in Royapettah they were equally attracted to both hosts.

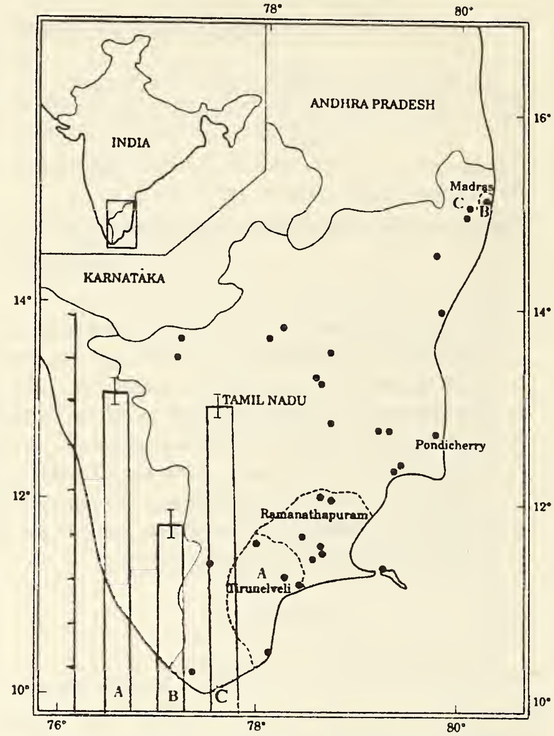

Fig. 1. Locations of three intraspecific female variants (A, B, C) of *P. argentipes* collected. Bar diagrams represent the mean no. of eggs laid per fly

(A) Veeravandiyur village, Tirunelveli
Total no. of flies captured (N) = 39
No. of eggs laid per fly

Mean (x)	=	71.64 ±3.64 (s.d)
Range (R)	=	65-77

(B) Royapettah in Chennai
Total no. of flies captured (N) = 21
No. of eggs laid per fly

Mean (x)	=	41.66 ±4.83 (s.d)
Range (R)	=	32-50

(C) Poonamalle village near Chennai
Total no. of flies captured (N) = 32
No. of eggs laid per fly

Mean (x)	=	69.00 ±4.46 (s.d)
Range (R)	=	54-76

Discussion

The present study reveals some intriguing biological variations in the oviposition behaviour of *P. argentipes* collected from 3 different places, their host preference and the mean number of eggs laid per fly. The eggs laid by the variants AC are similar in their oviposition sites and mean no. of eggs laid per fly, but both are quite different from B. The ecological distribution of these variants shows that A is allopatric to BC and B sympatric to C. AC are more strongly attracted to a blood meal from cattle than from humans. B is attracted to both cattle and humans, the latter providing a better opportunity to transmit kala-azar.

Several possible explanations can be given for the differences in behaviour and distribution of these variants. For AC, feeding on cattle appears to be more advantageous, as they offer a large, open body surface where the blood meal can be taken immediately after mating. Cattle blood is richer in iron than human blood and perhaps they are less sensitive to biting. Hence, cattle are preferred by AC. Human blood meal is preferred by B, which could be the vector of visceral leishmaniasis.

These observations coincide with the known findings on the two morphologically different species. In the present study, the intraspecific variants AC are similar to the morphological species A, which occurs in Tamil Nadu and the whole of South Asia and has perhaps no role in the transmission of kala-azar. The variant B found in Royapettah, and also reported from other major endemic areas like Bihar and West Bengal, is a morphologically identifiable species B and is considered a vector species.

P. argentipes is considered to be a species complex with member species differing in the lengths of the fourth antennal ascoids (Lewis and Killick-Kendrick 1973), of the labrums (Lewis 1987) and in cuticular hydrocarbons (Kamhawi *et al.* 1992). Recently, Ilango (1998) reported differences between the specimens of *P. argentipes* collected from endemic and non-endemic areas of visceral leishmaniasis, in which the relative size of the fourth antennal ascoids shows character displacement. According to Brown and Wilson (1956), character displacement is observed in two closely related species when their allopatric populations are very similar and their sympatric populations distinct in one or more characters. The disparate characters could be morphological or behavioural. In this study, the pattern of distribution and oviposition behaviour of three variants of *P. argentipes* suggests that it may consist of several isomorphic species distributed across the Indian Subcontinent.

According to Tabachnick and Black (1995), current species identification using isoenzyme analysis, DNA probes and PCR delimits species and provides genetic relationships. Molecular taxonomy promises to be an important tool for (1) discrimination of cryptic members of species complexes, (2) identification of morphologically similar species at any life stage, and (3) rapid identification of small arthropods (eg. mites, sandflies, *Culicoides*). Population genetics characterises genetic variation within and among populations of a species. Members of species complexes and morphologically similar species are likely to be descendents of populations that were once members of a single species. Studies that examine gene flow with respect to components of vector capacity provide insights into vector species complexes and variation within species.

Hence, molecular taxonomy and population genetics studies are urgently required to resolve the taxonomic status of *P. argentipes,* to understand the pathogenic transmission, epidemiology and control of the disease.

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FOOD HABITS AND ACTIVITY PATTERN OF THE COMMON OTTER *LUTRA LUTRA NAIR* (F. CUVIER) AT PICHAVARAM, TAMIL NADU, SOUTH INDIA[1]

G. UMAPATHY[2]

Key words: Common otter, *Lutra lutra nair*, food habits, activity pattern, Pichavaram mangrove forests

Food habits and activity pattern of the common otter (*Lutra lutra*) were studied in Coleroon and Uppanar rivers, in Pichavaram mangrove forest, in Tamil Nadu, during December 1991 to March 1992. A total of 2,552 records of diurnal activities were noted through group scan of a population in freshwater habitat. Two spraints were collected from brackish waters and 176 from the adjoining freshwater habitats. Swimming or moving was the major diurnal activity, followed by resting. Scat analysis showed that fish was the major food item in the diet, followed by crustaceans.

INTRODUCTION

Otters are considered as health indicators of wetland habitats (Foster-Turley *et al.* 1990). The otter population is declining in many wetlands due to pollution, deforestation and conversion of wetlands into agricultural and aquaculture lands (*op. cit.*). Studies on the European otter (*Lutra lutra*) have indicated that human disturbance is a major factor in the decline of its population (Joint Otter Group 1977). Studies on the population and feeding ecology of Indian otters are very limited (Hussain 1992). This paper reports some observations on the food habits of the common otter *Lutra lutra nair* in Uppanar and Coleroon rivers, at Pichavaram, on the east coast of India, in Tamil Nadu, from December 1991 to March 1992.

STUDY AREA

The study area adjoins the Pichavaram mangrove forest in South Arcot district, Tamil Nadu, on the east coast of India. It comprises a *c.* 5 km stretch of the Coleroon river and 15 km stretch of the Uppanar river (11° 25' N, 74° 47' E). The study area at Coleroon was about 2 km south of Pichavaram village and is called Block I. The width of the backwaters at Coleroon ranged from 250 to 300 m and depth from 2 to 5 m, during the dry season. Both banks were mostly covered with prawn culture farms and narrow strips of thick bushes. The site at Uppanar river covered about 8 km of freshwater habitat (Block II) and 7 km of estuarine habitat (Block III) and is to the north of Coleroon river. Blocks II and III were separated by a check dam, which formed a small reservoir of fresh water used for agricultural purposes and which provided a good habitat for otters. The width of Uppanar river varied from 10 to 15 m and depth from 1 to 5 m. The freshwater habitat (Block II) had a village (1 km stretch), paddy fields (3 km) and thick bushes (2 km) on its banks. The estuarine habitat (Block III) was covered with paddy fields (2 km), prawn farm (2 km), thorny bushes (2 km) and open land (2 km). The Uppanar river mouth was occupied by an extensive stretch of mangrove forest.

MATERIAL AND METHODS

The otters occurring in the study area were identified as *Lutra lutra nair* (Krishnan 1977).

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They were located by frequent surveys during early hours. A total of 176 fresh spraints (less than a week old) were collected from these localities. These were washed in a fine sieve; the various components were separated and broadly identified as fish, crab, prawn, insect and others. The percentage frequency of the various prey items was collectively calculated for all spraints, for each block. Time spent by otters on different activities was estimated by group scan (Altmann 1974), at intervals of 10 minutes, only from Block II since visibility in other areas was poor. The activities were categorized into feeding, resting, moving or swimming, playing and others. Success rates of foraging dives were also estimated. All observations were made from dawn to dusk, for six days each month, from December 1991 to March 1992. Since the animals were shy and aquatic, it was difficult to follow them continuously, but an average of 4 to 5 hrs of observation was possible in a day (range 2 to 8 hrs). The number recorded per scan varied from 3 to 6.

Percent time spent on an activity was calculated for each day from: $T_a = n_a \times 100/N$ where

T_a — % time spent on activity *a*

n_a — number of records with activity *a* and

N — total number of records for the day

An average of these percentages over the study period was used as an estimate of the time spent on each activity.

Results and Discussion

A total of 2,552 records of diurnal activities were made in 24 days. Moving or swimming was the major activity, taking 42.84% of the day time (range 30.1% to 53.7%). Resting was second, taking 30.87% of the day time (range 26.4% to 34.8%), while feeding was 20.3% (range 15.7% to 24.3%). Playing and other activities constituted 3.79% and 2.14% respectively.

Fish was the most common food item in the spraints collected in Block I (71.5%) and Block III (68.2%), and second most common in Block II (36.4%) (Table 1). Crustaceans (crabs and prawns) were common in the spraints in Block I and II, while crabs were most common in Block II (45.5%). 3% to 12% insects were found in the spraints. Whether the frequency of occurrence of various food items in otter spraints can be interpreted as the proportion of food intake is confounded by many factors, such as differences in prey size and proportion of indigestibility (Macdonald and Mason 1986).

Fish is a major food item of the European otter *Lutra lutra* (Kruuk *et al.* 1987), and smooth Indian otter *Lutra perspicillata* (Hussain 1992).

TABLE 1
PERCENTAGE OCCURRENCE OF DIFFERENT FOOD ITEMS IN OTTER SPRAINTS COLLECTED IN THE PICHAVARAM AREA, EAST COAST OF TAMIL NADU

Food item	Percentage occurrence of food items		
	Block I	Block II	Block III
Fish	71.54	36.36	68.18
Crab	14.30	45.45	9.10
Prawn	7.15	12.50	13.62
Insect	3.44	5.70	9.10
Others	3.57	0.00	0.00
Number of spraints analysed	80.00	32.00	64.00

In the former species, some habitat differences in the food preference were seen, with the crustaceans forming the main food item (Macdonald and Mason 1987).

Fifty-four feeding dives were recorded, of which 39 dives (72.0%) were successful. Of the successful dives, otters captured fish on 22 occasions (56.4%), crabs on 8 (20.5%), prawn once (2.5 %) and unidentified items on eight occasions (20.5%). This observation on feeding also indicates the dominance of fish in the diet. The differences between direct observation of feeding and spraint analysis in the Block II population, may be due to the otter feeding on smaller prey (mostly crabs) under water.

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FEEDING POTENTIAL OF *CASSIDA CIRCUMDATA* HERBST (CHRYSOMELIDAE : COLEOPTERA) ON *IPOMOEA REPTANS* (LINN.) (CONVOLVULACEAE)[1]

M. John George[3] and Ipe M. Ipe[2]

(*With one text-figure*)

Key words: *Cassida circumdata*, Coleoptera, *Ipomoea reptans*, Convolvulaceae

The tortoise beetle *Cassida circumdata* Herbst feeds on the aquatic plant *Ipomoea reptans* (Linn.) (Family: Convolvulaceae), which grows profusely in the tropical wetlands. This plant species was found invading the open water area and changing the proportion of habitats available for aquatic birds and fishes. The different larval instars and adults of the tortoise beetle were noticed feeding on the leaves and tender stems of *Ipomoea reptans*, one of the abundant aquatic plants in Keoladeo National Park, Bharatpur, Rajasthan, which is among the major protected wetlands in India.

To assess the impact of *Cassida circumdata* on its main host plant *I. reptans*, consumption of the leaves in terms of area fed by different larval and adult stages were studied under laboratory conditions (30 ±2 °C and 50-70% relative humidity). The first to fifth instar larvae and adult differed widely in their consumption of host plant leaves. The area consumed was in the order 1st <2nd <3rd <4th <5th instars > adult. Significant correlation could be obtained between the growth of the larvae and their food consumption. The different rates of food consumption indicate the varying energy requirements of the various larval stages of the beetle.

Introduction

Recently, much attention has been given to the herbivore-plant relationship, with reference to its ecological and evolutionary impacts (Denno and McClure 1983). Such studies demand a knowledge of the actual consumption of the host plant parts by the herbivore and its growth rate. The quantitative assessment of consumption of host plants by its pest may help us to assess the impact of the pest on the growth of the plant and thereby the possible use of that pest as an agent of biological control.

The tortoise beetle *Cassida circumdata* Herbst feeds on the aquatic plant *Ipomoea reptans* (Linn.), which grows profusely in tropical wetlands. About 91 species of wetland macrophytes have been identified from the Keoladeo National Park of which the most dominant species is a grass, *Paspalum distichum*, that covers a major part of the aquatic area. The rest is mostly covered with *Ipomoea reptans*, an important amphibious herb. *Ipomoea reptans* floats in water, usually appears as a trailing herb and changes the proportion of the habitat available for aquatic birds and fishes (Ali and Vijayan 1986). In the Park, *I. reptans* remains in a dormant stage during winter (December-February).

In summer (April-June), as the water level drops and the stem makes contact with the ground, it produces leaves in large numbers. After monsoon and when the level of water rises, *I. reptans* spreads and attains maximum growth. This paper reports the result of the study carried out in the field and under laboratory conditions, to determine the feeding potential of *C. circumdata*.

The life-cycle of *C. circumdata* includes 5 larval stages and a pupal stage. The eggs were laid on the ventral side of *I. reptans* leaves. Under

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laboratory conditions (30 ±2 °C), the eggs hatched within 4 days. The duration of the 5 larval instars was 2, 1-2, 2, 2 and 4 days respectively. The pupal stage lasted for 4 days.

Study area

The present study was carried out in the well-known protected wetland, the Keoladeo National Park, Bharatpur (27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E), Rajasthan, India.

Methodology

Both sexes were almost alike, the male being slightly smaller than the female. To study the feeding and oviposition, experiments were carried out in plastic containers (height = 8 cm and diameter = 3 cm) with screw top having holes for ventilation. Discs of filter paper were placed at the bottom of the containers to absorb excess moisture and facilitate cleaning. Mating pairs were collected from the field and kept in these containers. The leaf-area fed by the adult and the eggs laid after 24 hrs were recorded. The adults, when kept in containers laid eggs on the leaves of *I. reptans*, and the eggs hatched within 4 days.

Newly emerged larvae were placed one in each container and provided with fresh leaves of *I. reptans* daily. The body length and breadth were measured every 24 hrs using a compound microscope with a calibrated ocular micrometer. When fresh leaves were freely available, the larvae and adults fed upon the fresh area. The leaf area consumed and removed at one meal (leaf area fed at a stretch) was measured by placing the leaf on graph paper and tracing the leaf area fed, and then counting the squares of the leaf area fed, as suggested by Simmonds (1949). As the early instars fed very little and made circular holes, the radius of the circular path fed was measured with graph paper and by a calibrated, ocular micrometer. To estimate the quantity of food consumed by the adult and grub of *Lema lacordairei* (Chrysomelidae), Visalakshi and Nair (1987) used similar methods.

Along with the experimental studies in the laboratory, an attempt was made to quantify the feeding impact of different instars of the beetle on the host plant. This was carried out by collecting the plant and different stages of the beetles from randomly placed quadrats of 100 x 100 sq. cm. Collections were made from 6 study plots. Once the quadrat was placed, all the leaves above water were plucked and transferred into plastic bags (harvest method). The adults that flew off on being disturbed were also counted. In the laboratory, all the leaves were carefully examined and the different instars and adults counted. The leaf area was measured using the same method as above. The leaf biomass was quantified using an electrical monopan balance of sensitivity 0.1 mg. The samples were taken once in seven days and monthly averages were calculated.

Results and discussion

Lab experiment: The average leaf area of *Ipomoea reptans* consumed and the average growth (length and breadth) of the larvae of *Cassida circumdata* for each day are summarized in Table 1. The maximum leaf area was consumed on the eighth day by the 5th instar larva (59.33 sq. mm). The maximum increase in the larval stage was noted on the seventh and eighth day. On the ninth day, the larvae slowly decreased their rate of feeding and entered pupation. The 5th instar larva fed about 101.16 sq. mm leaf area within 3 days. The maximum area was fed upon by the two day old 5th instar larva. This study showed that the 5th instar larvae can consume almost 4 times more than the 4th instar and about 100 times more than the 1st instar (Table 1).

A single larva from the 1st through the 5th instar consumed about 145.95 sq. mm leaf

TABLE 1
FOOD CONSUMPTION AND GROWTH OF THE LARVAE OF *C. CIRCUMDATA* REARED ON *I. REPTANS* IN THE LABORATORY (30±2°C)

Days	1	2	3	4	5	6	7	8	9	10	11
Stage (instar)	1st	2nd	3rd	3rd	4th	4th	5th	5th	5th	Pupa	Pupa
Increase in length (mm)	0.15	0.28	0.3	0.2	0.45	0.45	0.75	0.58	0.18	-0.08	0
Increase in breadth (mm)	0.08	0.17	0.15	0.13	0.37	0.17	0.38	0.55	0	0	0
Area fed (sq. mm)	1.86	5.01	4.68	9.83	9.65	16.79	30.25	59.33	11.58	0	0

area of *I. reptans* within 9 days (Table 1). The average leaf area collected during July-October was 17.55 sq. cm. The study showed that two larvae from the 1st instar through 5th instar can completely eat and skeletonise a single leaf.

To study the feeding behaviour of the beetle, the host plant leaves were observed when there was less attack. Of the total holes fed and made by the larvae and the adult (N = 5,265 holes) 95.5% of the holes indicated only one feeding. This indicates that the larvae and adults preferred to feed on fresh area when the host plant leaves were plentiful.

The leaf area fed and removed at one meal (in a stretch) by each instar larva and adult are summarized in Table 2. The result showed that the 5th instar larvae consumed greater leaf area at a single meal and the first instar the least.

The adult *C. circumdata* pair under captivity (N=15) fed on 56.81 ±12.53 sq. mm leaves and laid 12.6 ±6.1 eggs within 24 hrs. The mating pairs fed 17.1 ±4.8 times within 24 hrs. The area fed upon by the mating pairs was less compared to the 5th instar larva, as more time was utilized for mating and laying eggs. No significant correlation was noticed between the area fed and the number of eggs laid.

Simmonds (1949) assessed the leaf area consumed each day by the larvae of *Physonota alutacea* (Cassidinae). The leaf area consumption was seen to increase with the growth of the larvae each day, the maximum consumption of leaf area was noted on the 16th day. In *Aspidomorpha miliaris,* the adult consumed seven times more leaf area than the 5th instar (Manjunatha *et al.* 1987). *Bombyx mori* and *Protoparce sexta,* both lepidopterous leaf feeders, eat about 97% of their total intake during the last two instars and about 99% during the last three instars respectively. In *Bombyx mori*, it was noticed that the efficiency of storage of metabolizable energy increases with age, reaching its peak in the 5th instar. The large amount of energy stored during 5th instar is, of course, needed to support the non-feeding pupa and adult (Waldbauer, 1968).

TABLE 2
LEAF AREA OF *I. REPTANS* CONSUMED (SQ. MM) BY THE LARVAE AND ADULT *C. CIRCUMDATA* AT 30 ±2°C (N=80)

1st instar	0.21 ±0.13
2nd instar	0.35 ±0.19
3rd instar	0.80 ±0.37
4th instar	1.86 ±0.82
5th instar	5.32 ±3.41
Adult	3.77 ±1.72

Field experiments: Field observations revealed that the beetle appears in the study area during March (mean min. temp. = 19 °C). The host plant was available only along the dykes. The population of *C. circumdata* remained almost constant during the peak summer months. With the onset of monsoon and the release of water from Ajanbund, an inundation reservoir situated 0.5 km south of the Park, the plant spread

over the area by vegetative reproduction. There is spatial variation in the abundance of this plant in the Park. By this time, the beetle had settled in different areas. The adults mainly concentrated in certain areas, fed and laid eggs. There was wide fluctuation in the population of different stages of the beetle among the different study plots. After laying eggs, the adults move to other less infected areas. The adult beetles prefer to lay eggs on the underside of fresh young leaves. Eggs were never laid on skeletonised leaves, to ensure enough food for the emerging larva.

The average maximum number of different stages of the beetle was noted during September (Fig. 1). The leaf area of the host plant was found following the same trend as that of the beetle. Thus, a significant positive correlation was obtained between biomass and leaf area of the plant with the population of the beetle ($r = 0.821$, $p = 0.001$; $r = 0.8472$, $p = 0.0001$, $n = 60$).

It was observed that the host plant compensated for the leaf area fed upon by the larval and adult *C. circumdata* by producing larger leaves. Leaves with greater surface area were noticed in August and September during 1985, when the population of the beetle was at its peak (Fig. 1). But in a later study during 1986-87, a similar response of the host plant could not be observed due to low population of the beetle (George 1988). The maximum population (468/ sq. m) and leaf area (17.8 sq. mm) during 1986, was noticed in September.

Kolodny-Hirsch and Harrison (1982) conducted field and field cage studies to compare larval injury by the tobacco bud worm, *Heliothis virescens* and corn ear worm, *Heliothis zea* (Lepidoptera: Noctuidae). Their observations showed that the plant compensated for leaf loss by increasing the laminal area of the damaged leaves.

The population of *C. circumdata*, in the Park, reached a peak in September, and as a result the leaf area and biomass declined. In the end, only leaf skeletons remained in the infested areas. Thus, leaf biomass became zero towards the onset of winter. In winter, both the plant and its pest remained dormant. The beetles were found hibernating, in the Park, on terrestrial plants, namely *Salvadora persica*, albeit in small numbers (George 1988). This formed the breeding stock for the next population during February-March, and by this time the host plant also starts producing smaller leaves. Thus, the interrelated life-cycles of the host and pest continue.

The study unravels a unique relationship between the plant and the beetle. Though the beetle controls the biomass of the host plant, it

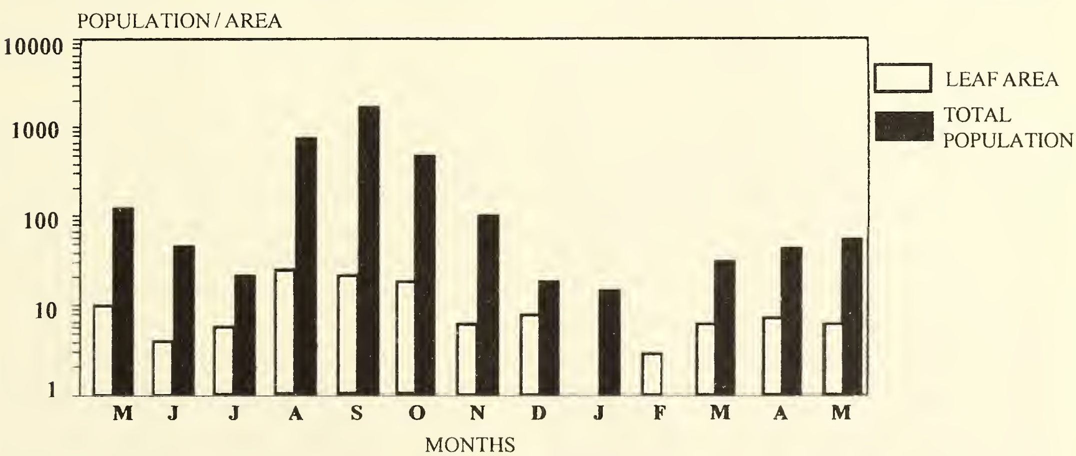

Fig. 1: Leaf area (sq. mm) of *I. reptans* and population of *C. circumdata*

does not completely destroy them, thereby ensuring its own survival. The most important barriers which prevent the beetle from destroying the plant entirely are the ability of the plant to survive under water and low ambient temperatures (average minimum temp. in December-February 8 °C).

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HABITAT PREFERENCES AND DISTRIBUTIONAL STATUS OF SOME FOREST BIRDS IN ANDAMAN ISLANDS[1]

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Key words: Habitat preferences, distributional status, forest birds, Andaman Islands, India

The habitat preferences of 30 species of forest birds were studied in Baratang Island in the Andamans, India. The relationship between habitat preferences and large-scale patterns, such as biogeographical distribution of each species on the continent of Asia and distributional status within the Andaman Islands was analysed. The birds fell into five categories, those found predominantly in only one habitat type, evergreen or deciduous forest, and those which used a broader range of habitats, which were classified on the basis of their relative occurrence in each habitat type as semi-evergreen, moist deciduous or generalist species. The habitat preferences of these 30 species showed no association with either the biogeographical distribution or with status, suggesting that large-scale distributional patterns are not related to habitat preferences.

Introduction

Within a geographical area, species are not evenly distributed across all available habitats, but tend to use some habitats more than others. A species is found with greatest frequency and abundance in the habitats to which it is best adapted (Crowell 1962). These preferences might change across geographical areas and over seasons. Alteration and destruction of habitats by humans can have a drastic effect on some species, while others adapt to the modified habitat. Therefore, data on the habitat requirements of a species could be useful for predicting the effects of habitat alteration due to humans on natural communities.

Habitat preference of a species might limit its dispersal and subsequent colonisation. It is presumed that species restricted to a habitat would be relatively infrequent in a geographical area and its geographical range would be restricted. Its presence depends on the occurrence of the specific habitat in that area. On the other hand, generalist species would be common, occurring over a large area (Brown 1984).

This study examines the habitat preferences of 30 species of forest birds on Baratang Island, Andamans, India, and whether there is any relationship between their habitat selection at the local level with broad geographical patterns, such as distribution on the continental mainland and overall status in the Andamans.

Study area

The Andamans are a part of the Andaman and Nicobar Islands, comprising of more than 300 islands in the Bay of Bengal. They extend from southwestern Myanmar to northwestern Sumatra, lying between 6° 45' and 13° 41' N. They are postulated to be a part of the Arakan Yoma mountain range of Myanmar, which lies submerged. They are considered true oceanic islands as they were never connected to the Asian continent during the Pleistocene glaciation. Maximum overwater colonisation possibly occurred before the Andaman Sea expanded (Ripley and Beehler 1989, Halde *pers. comm.*). The Andaman group consists of four large islands, North, Middle, Baratang and South Andaman Islands, forming a super island of over

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5,000 sq. km with archipelagoes and isolated islands surrounding it. The climate is tropical and oceanic with about 3,000 mm annual rainfall received from both the southwest and northeast monsoons. The dry season extends from February to May.

This study was conducted on Baratang Island, which lies between the Middle and South Andaman Islands. Baratang has been selectively logged and some areas clear felled since the early 20th century; selective logging continues in parts of this island. More than 75% of the sites sampled on Baratang had been selectively logged.

Of the forest types described (Champion and Seth 1968), the common and dominant forms that were considered as distinct habitat types in this study are:

1. Evergreen forest: These are multi-storied climax forest formations that occur mostly on low alluvial land or on moist loamy hillsides, with representative trees such as *Dipterocarpus* spp., *Canarium manii*, *Artocarpus* sp., *Pometia pinnata*.
2. Semi-evergreen forest: Mainly confined to valleys and slopes, containing both evergreen and deciduous trees. Some tree species are *Dipterocarpus alatus*, *Pterygota alata*, *Albizia chinensis*, *Bombax insigne*, *Artocarpus lakoocha* and *Pterocymbium tinctorium*.
3. Deciduous forest: Forests of lower stature growing on lower hills and in drier areas. Common species are *Pterocarpus dalbergioides*, *Terminalia bialata*, *Dalbergia* spp., *Pterocymbium tinctorium*, *Albizia* spp. and *Tetrameles nudiflora*.

The evergreen and deciduous forests are structurally different from each other, especially during the dry season when the deciduous trees lose their leaves. This study was conducted during the dry season (February, March) of 1993.

Methods

The abundance and habitat use patterns of 30 species of forest birds were recorded in Baratang Island. Approximately half the forested area of Baratang is deciduous and the rest semi-evergreen and evergreen forest. Transects of one km length were laid in each forest type, the number varying with the size of each habitat type. There were 3 transects in evergreen forest, 4 in semi-evergreen forest and 6 in deciduous forest. The transects were walked in the mornings between 0700 and 1000 hrs, and all birds seen and heard were recorded. The identification was based on Ali and Ripley (1987).

To find the habitat preference of a species, the mean number of individuals recorded per km of transect in each habitat was calculated. This eliminates error due to unequal sampling among habitats. Comparison of this abundance index across different habitats gives the relative habitat occurrence of a species (Table 1). Species that were observed with a frequency of more than 60% in at least one habitat are considered common species and are included in the analyses.

From the relative occurrence values, species are placed in the following five categories:

1. Evergreen forest species: Found predominantly in the evergreen forest and less frequently in the semi-evergreen forest.
2. Semi-evergreen forest species: Found in equal proportion in evergreen and semi-evergreen forest, rarely in deciduous forest.
3. Deciduous forest species: Recorded predominantly in deciduous forest and infrequently in other forest types.
4. Moist deciduous species: Recorded in approximately equal proportion in deciduous and semi-evergreen forests, but rarely in evergreen forest.
5. Generalist species: Found in equal proportion in the evergreen and deciduous

TABLE 1
RELATIVE OCCURRENCES OF BIRDS IN VARIOUS HABITAT TYPES ON BARATANG ISLAND

Species	No. of birds recorded	Relative occurrence in each habitat type (%) Evergreen	Semi-evergreen	Deciduous	Habitat preference
Dryocopus hodgei	8	31	69	0	Semi-evergreen
Dendrocopus macei	4	0	0	100	Deciduous
Centropus andamanensis	7	25	0	75	Deciduous
Loriculus vernalis	8	44	56	0	Semi-evergreen
Psittacula eupatria	6	40	60	0	Semi-evergreen
Psittacula alexandri	12	0	23	77	Deciduous
Psittacula longicauda	27	49	44	7	Semi-evergreen
Columba palumboides	4	100	0	0	Evergreen
Ducula aenea	68	49	41	10	Semi-evergreen
Macropygia rufipennis	6	73	27	0	Evergreen
Chalcophaps indica	5	67	33	0	Semi-evergreen
Treron pompadora	10	84	16	0	Evergreen
Irena puella	11	53	47	0	Semi-evergreen
Dendrocitta bayleyi	9	17	50	33	Moist deciduous
Oriolus chinensis	20	25	12	63	Deciduous
Coracina macei	7	25	0	75	Deciduous
Pericrocotus cinnamomeus	20	0	65	35	Moist deciduous
Pericrocotus flammeus	20	62	19	19	Semi-evergreen
Dicrurus andamanensis	14	0	29	71	Deciduous
Dicrurus paradiseus	19	51	39	10	Semi-evergreen
Hypothymis azurea	6	44	33	22	Semi-evergreen
Copsychus saularis	8	22	0	78	Deciduous
Aplonis panayensis	44	0	62	38	Moist deciduous
Sturnus erythropygius	14	0	46	54	Moist deciduous
Gracula religiosa	23	93	7	0	Evergreen
Pycnonotus atriceps	15	54	14	32	Generalist
Pycnonotus jocosus	18	0	16	84	Deciduous
Zosterops palpebrosus	10	31	23	46	Generalist
Dicaeum concolor	11	29	21	50	Generalist
Nectarinia jugularis	9	33	25	42	Generalist

forests, less commonly in the semi-evergreen forest.

The biogeographic distributional ranges of all breeding species present in the Andaman Islands are given in Ripley and Beehler (1989). We ranked each of our study species based on their presence in the four biogeographic regions, with which the Andaman birds have close affinities. Species endemic to the Andaman and Nicobar Is. are given a rank of 1 and for others, the number of regions in which the species is distributed are added to calculate a value. For example, if a species is found in Myanmar, Sumatra, the Malay Peninsula and in South India, it receives a value of 4.

The rank of each species indicative of its distributional status is taken from Davidar *et al.* (1996). The rank of a species is a composite of its abundance rank, based on the total number recorded, and its distributional rank based on the number of islands on which it was recorded, out of the 45 islands surveyed in the Andamans (Davidar *et al.* 1996).

Rank correlation, contingency table and correspondence analyses were performed to detect any relationship between biogeographic

distributions, status within Andamans and habitat preferences.

Results

The habitat preferences of the 30 species indicate that they occupy a range of habitats, from strictly evergreen or deciduous forest to all these habitats, but in different proportions. Of the 30 species, 12 are habitat specialists, four being limited to evergreen forest, and eight to predominantly deciduous forest. The rest are more broadly distributed; 10 species being classified as semi-evergreen, 4 as moist deciduous and four as habitat generalists (Table1).

Table 2 provides information on habitat preferences of the species, their biogeographic distributional range and rank indicative of status. Only the relationship between biogeographic range and status is significant (Kendall's $t_b = 0.4305$, $p<0.01$). This suggests that species with a broad biogeographical distribution are also more common and widely distributed in the Andaman Islands. The habitat preference of species is not significantly related to either biogeographical range or status within Andaman Islands.

Discussion

This study on 30 species of forest birds in Baratang Island indicates that there is a diversity of habitat preference among these species. Approximately half the species studied preferred wet forest, and the rest drier forest. This suggests that the avifauna might fall into two broad categories, those with affinities to wet biogeographic zones on the mainland, and the others of a more deciduous origin. Pigeons and parakeets mostly preferred wet forests in the Andaman Islands, whereas in drier forests no such phylogenetic pattern could be seen.

The results show that there is no relationship between habitat preferences and biogeographic distributions. Species with narrow habitat use patterns did not correspondingly have narrow distributional range on the continent. Their presence in the Andamans depends, perhaps, on their ability to colonise overwater and not to being

Table 2

HABITAT PREFERENCES, BIOGEOGRAPHIC DISTRIBUTIONS AND RANKING ON RARITY/ COMMONNESS SCALE OF 30 SPECIES OF FOREST BIRDS IN THE ANDAMAN ISLANDS

Species	Habitat preference	No. of biogeographic regions [1]	Status rank [2]
Columba palumboides	E	1	2
Macropygia rufipennis	E	1	3
Treron pompadora	E	2	6
Gracula religiosa	E	4	6
Dendrocopus macei	D	2	5
Centropus andamanensis	D	1	5
Psittacula alexandri	D	2	6
Oriolus chinensis	D	2	9
Coracina macei	D	3	5
Dicrurus andamanensis	D	1	5
Copsychus saularis	D	4	7
Pycnonotus jocosus	D	3	10
Dryocopus hodgei	S	1	4
Loriculus vernalis	S	3	7
Psittacula eupatria	S	2	5
Psittacula longicauda	S	2	6
Ducula aenea	S	4	9
Chalcophaps indica	S	4	5
Irena puella	S	4	9
Pericrocotus flammeus	S	4	4
Dicrurus paradiseus	S	4	9
Hypothymis azurea	S	4	7
Dendrocitta bayleyi	M	1	2
Pericrocotus cinnamomeus	M	4	9
Aplonis panayensis	M	3	7
Sturnus erythropygius	M	1	7
Pycnonotus atriceps	G	3	2
Zosterops palpebrosus	G	4	9
Dicaeum concolor	G	4	7
Nectarinia jugularis	G	3	10

E = Evergreen, D = Deciduous, S = Semi-evergreen, M = Moist deciduous, G = Generalist.

[1] Ripley and Beehler (1989): 1 = endemic to 4 = distributed on four biogeographic regions on the continent

[2] Davidar *et al.* (1996): 1 = rare to 10 = very common

generalised or specialised in habitat use. Ripley and Beehler (1989), in fact, found that there is a disproportionate richness of some phylogenetically related species in the Andaman and Nicobar Islands, and weak dispersers like the passerines are poorly represented.

There is also no relationship between habitat preferences and overall status of species within the Andamans. This shows that species with narrow habitat use patterns are not necessarily uncommon and vice versa. However, species that preferred evergreen forests occurred as rare to moderately common, but did not occur very commonly (maximum status rank 6), whereas species that preferred deciduous forests occurred as moderate to highly common and were never rare (minimum status rank 5). Species with broader habitat preferences generally occurred commonly (status rank above 4, except the Andaman tree pie *Dendrocitta bayleyi* and black-headed bulbul *Pycnonotus atriceps* that occurred only on large islands and were therefore ranked rare). The habitat generalists that use wet and dry forests equally, like the small sized *Zosterops palpebrosus*, *Dicaeum concolor*, and *Nectarinia jugularis,* occurred commonly and have wide biogeographical ranges.

Endemic species did not show any relationship between habitat preference and status. Species like *Columba palumboides* and *Macropygia rufipennis* were evergreen specialists; *Dicrurus andamanensis* and *Centropus andamanensis* were deciduous specialists. Three other endemics used a wider variety of habitats, but none of them were generalist. Similarly, some endemics were relatively rare, e.g., *Columba palumboides* and *Dendrocitta bayleyi*, but others like *Sturnus erythropygius* and *Centropus andamanensis* were common. However, none of the endemics were very common (median status rank 4). This lack of relationship between habitat preference and status does not conform to the theory that species of wider habitat use are more common than those that are restricted in habitat use (Brown 1984). Lawton (1993) drawing upon empirical data from several studies also found great variation in the conformity to the hypothesis, which predicts a positive correlation between niche breadth, range size and abundance.

Biogeographic distribution and status of species in the Andamans are significantly positively correlated, suggesting that more common species on the island also have a broader distribution on the continent. This pattern does not contradict the general theory on relationship between distribution and abundance (Brown 1984, Lawton 1993) as well as the null model (*sensu* Connor and Simberloff 1979), which proposes that a common species on the continent is more likely to be present in the random subset that colonises an island.

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FORAGING BEHAVIOUR OF CARPENTER BEES, GENUS *XYLOCOPA* : XYLOCOPIDAE : HYMENOPTERA, AND THE POLLINATION OF SOME INDIAN PLANTS[1]

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Key words: Foraging behaviour, pollination, carpenter bees, *Xylocopa latipes, X. pubescens*

Carpenter bees, or species of *Xylocopa,* are prominent members of the Indian bee fauna. They are found throughout the year, foraging in daylight and rarely through the moonlit hours. Some plant species are adapted specifically to pollination mediated by nectar-seeking carpenter bees. Such flowers protect the nectar chamber against piercing. Some offer pollen from poricidal anthers as the only reward. By their flower-foraging behaviour, carpenter bees provide an excellent service to the plants that they pollinate, especially obligate outcrossers like *Gmelina* and *Cochlospermum.* The different types of foraging behaviour exhibited and the role played by carpenter bees in the pollination of various plant species occurring in Visakhapatnam, Coringa and Giddalur in Andhra Pradesh are discussed.

Introduction

Large carpenter bees of the cosmopolitan genus *Xylocopa* (Family Xylocopidae, Hymenoptera) are the most prominent members of the Indian bee fauna. They are usually black on the abdomen and variously coloured in the thoracic region. They nest in soft dead wood of various plant species. Male and female vary in size, and generally both have long tongues. They feed on the flowers of various plant species blooming at different times of the year. Their foraging activity is usually limited to daylight hours, but some extend their activity into moonlit hours as well (Maxwell-Lefroy and Howlett 1971). The male carpenter bees collect only nectar, while the females gather pollen and nectar to provision brood cells. Both have a high energy expenditure when foraging (Chappel 1982) due to their large mass, and this expenditure must be balanced by energy obtained from nectar sugar.

The bees can carry quantities of nectar and pollen that are large, relative to the amounts usually available in flowers, and thus they visit many flowers or plants during a foraging trip. While probing the flowers for pollen or nectar, the bees usually contact stigmas and anthers, and thereby pollinate flowers. Some plant species with obligate outcrossing ability are exclusively pollinated by carpenter bees, while some others with self- and outcrossing ability are also pollinated by other insects. Further, there are mutualistic pollinating relationships between carpenter bees and plants (Snow and Roubik 1987, Scott *et al.* 1993). The carpenter bees exhibit various flower-foraging behaviours such as opportunistic, territorial, traplining, buzzing, and others for utilising forage efficiently. These behaviour patterns benefit the plants largely in outcrossing. Altogether, the foraging of carpenter bees provide an excellent service for plants that they pollinate, especially for obligate outcrossers, and enhances the fecundity and adult maintenance in bees. In view of the importance of foraging behaviours of carpenter bees in pollination, this paper aims at describing the floral, structural and functional features of 15 plant species and their adaptations to pollination by carpenter bees *Xylocopa latipes* and *X. pubescens* (Table 1). Of these, two are mangrove plant species, *Acanthus ilicifolius* and *Caesalpinia nuga*, occurring in estuarine habitats of Coringa (16° 55' N, 82° 15' E). Two others, *Anisomeles malabarica* and *A. indica* are

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TABLE 1

DETAILS OF FLOWERS AND FORAGERS OF DIFFERENT PLANT SPECIES

Plant species	Flowering period	Flower opening	Anther dehiscence	Flower colour	Nectar volume (μl)	Nectar concentration (%)	Breeding system	Flower visitors	Forage collection	Foraging behaviours of carpenter bees
ACANTHACEAE										
Acanthus ilicifolius	May-Aug	Day-time	L	Bl	5.0	35-40	X, G	Cb, Sb	N	Te
ALANGIACEAE										
Alangium salvifolium	Feb-Apr	24-hours	L	Cr	0.8	25-29	X, G	B, Cb, W, F, Bu	N, P	Te, Tr
LAMIACEAE										
Anisomeles malabarica	Oct-Jan	0100-0500	L	Pu	1.8	30-48	X, G, A	B, Cb, W, An, Th, Bu, Sb	N, P	Te, Tr
A. indica	Oct-Jan	0530-0730	L	Pu	1.6	32-43	X, G, A	B, Cb, W, An, Th, Bu, Sb	N, P	Te, Tr
CAESALPINIACEAE										
Bauhinia purpurea	Oct-Jan	0430-0530	L	Pu	T	5-7	X, G, A	B, Cb, W, Bu,	N, P	Op
Caesalpinia nuga	Mar-Jan	0600-1000	L	Ye	T	-	X, G (?)	Cb	N	Tr
Cassia alata	Oct-Feb	0300-0400	P	Ye	-	-	X, G	Cb	P	Buz
Peltophorum pterocarpum	Mar-Jun	Forenoon	L	Ye	T	-	X, G	B, Cb	N, P	Buz
Tamarindus indica	Apr-Aug	2300-0400	L	Cr	1.0	6-8	X, G	B, Cb, An, W, F, Bu	N, P	Tr
COCHLOSPERMACEAE										
Cochlospermum religiosum	Jan-Apr	2300-2400	P	Ye	-	-	X, G	B, Cb	P	Buz
LECYTHIDACEAE										
Couroupita guianensis	Feb-Mar	0700	L	Ye	-	-	X	B, Cb	P	Op
FABACEAE										
Gliricidium sepium	Jan-Mar	0730-1600	L	La	3-4	34	X, G	B, Cb	N, P	Tr, Op
VERBENACEAE										
Gmelina aisatica	Mar-Oct	0500-0600	L	Ye	75-80	20-28	X, G, A	B, Cb	N, P	Tr
MARTYNIACEAE										
Martynia annua	Jul-Oct	0400-0500	L	Bl	15	5-7	X, G, A	B, Cb, H	N, P	Op
MORINGACEAE										
Moringa oleifera	Feb-May Sep-Nov	0500-0900	L	Wh	1.3	5-18	X, G	B, Cb, An, W, F, Bu	N, P	Tr, Op

L-Longitudinal, P-Poricidal, Ye-Yellow, Cr-Creamy-white, La-Lavendar, Bl-Blue, Pu-Purple, Wh-White; T-Traces, X-Xenogamy, G-Geitonogamy, A-Autogamy; B-Bees, Cb-Carpenter bees, F-Flies, W-Wasps, An-Ants. Th-Thrips, Bu-Butterflies, H-Hawkmoth, Sb-Sunbirds; N-Nectar, P-Pollen; Te-Territoriality, Tr-Traplining, Op-Opportunistic, Buz-Buzzing.

inhabitants of the foothills of Giddalur area (15° 10' N, 18° 45' E); all others occur in Visakhapatnam (17° 42' N, 82° 18' E).

The floral features and foraging behaviour of carpenter bees with reference to pollination have been reported by Aluri (1990, 1993); Aluri and Subba Reddi (1989, 1994, 1996a, b); Bhaskara Rao and Subba Reddi (1994a, b); Jyothi *et al.* (1990); Subba Reddi and Aluri (1997); Subba Reddi and Bhaskara Rao, (1993); and Subba Reddi *et al.* (1996, 1997). The foraging behaviour of carpenter bees and breeding systems have been further studied extensively in the field, where the abovementioned plant species occur.

Floral details and foraging behaviour of carpenter bees

1. ***Acanthus ilicifolius* L.** (Acanthaceae): This plant grows in the estuarine habitats of Coringa and adjoining areas in the Godavari delta and flowers during May-August. Its flowers are large, blue and nectariferous. The flower has a cartilaginous corolla tube, terminating in an upper lip sheltering stamens and the pistil, and a lower lip which serves as a landing site for foragers. The stigma projects beyond the anthers. The pollen receptacle consists of fertile and sterile anthers, which are firmly interlocked. Separation of these locules and subsequent liberation of pollen are possible only by large-bodied pollinators. The flowers are visited by carpenter bees along with sunbirds for nectar; both are equally efficient in exploiting the nectar and effecting cross-pollination. While probing the flower, the carpenter bee inserts its proboscis through the pollen receptacle with much force to get at the nectar. This results in the separation of fertile locules from the sterile ones and shedding pollen on to the back of the bee and on the stigma. If the bee carries pollen from the previously visited flower, it results in cross-pollination or else effects selfing. The separated anther locules regain their original position with the departure of the bee. In consequence, the flowers receive multiple visits, hence cross- or self-pollination is ensured. The bees show fidelity to this plant throughout its flowering by exhibiting territorial foraging behaviour to exploit the nectar.

2. ***Alangium salviifolium* (Linn. F.) Wang.** (Alangiaceae): A small deciduous tree, it sheds leaves before flowering. It flowers during February-April. Although the flowers are open day and night, they are foraged for pollen and/or nectar by diurnal insects — bees, wasps, flies and butterflies. Of these, carpenter bees show fidelity to this plant by foraging throughout the flowering period and largely effecting cross-pollination. The flowers stand out visually by their large display and by shedding leaves which attract the bees. The carpenter bees exhibit traplining and territorial foraging behaviour. Traplining is employed to forage on the distantly spaced plants intermingled with other plant species, and territoriality to forage on the plants aggregated in one place. These two behaviour patterns occur throughout the flowering period, and probably promote xenogamy.

3 & 4. ***Anisomeles malabarica* R. Br.** and ***A. indica* O. Kuntze** (Lamiaceae): These two species are herbaceous perennials and grow from both rootstock and seed. *A. malabarica* shows vegetative growth in July, flowers during mid-October and disappears in January. *A. indica* shows vegetative growth and flowers during October to mid-January. It exhibits flowering episodes in response to water stress. The flowers open from 0100-0500 hrs in *A. malabarica* and from 0530-0730 hrs in *A. indica*. The flower structure of the two species is similar. The flowers are purple, showy, large, fragrant, bisexual and nectariferous. They are bilabiate, with stamens and style extending beyond the small upper lip resembling the classical gullet type blossom. Day-flying bees, wasps, ants, thrips, butterflies and sunbirds visit the flowers of both species, of which only carpenter bees and sunbirds are regular and perform efficient and effective

pollination. Other foragers visit the flowers occasionally, and some of them deplete the floral forage by probing from the side of the flowers, bypassing the pollination apparatus. The carpenter bees, after landing on the strong lower lip, probe flowers in an upright position for nectar, during which the stigma situated near the tip of upper lip contacts the residual pollen in the dorsal crevice of the bees. The male carpenter bees exhibit territorial and traplining foraging behaviour and collect only nectar. This dual behaviour greatly profits the taxa in achieving outcrossing. Sunbirds are equally important for pollination. They feed on the nectar of flowering *Anisomeles* throughout winter.

5. ***Bauhinia purpurea* Linn.** (Caesalpiniaceae): An evergreen, popular ornamental tree, flowers during October-December; some trees may flower up to February. The flowers open daily from 0430-0530 hrs. They are large, purple, showy, bisexual and nectariferous. The flowers are dichogamous, showing anther dehiscence in 1st day flowers and stigmatic receptivity in 2nd day flowers. This floral trait precludes self-pollination. The availability of both phases in different flowers on the same plant on a day facilitates geitonogamy. The flowers are foraged by bees, wasps and butterflies; bees are regular, consistent foragers, while wasps and butterflies are occasional and least important in effecting pollination. Among bees, the carpenter bee and the digger bee *Amegilla,* are the principal pollinators. The carpenter bee usually alights on the staminal filaments and crawls into the flower, seeking nectar. While taking off, the bee's body touches the anthers and the pollen is deposited on the dorsum. If the bee, after its visit to a 1st day flower, visits a 2nd day flower, the receptive stigma contacts precisely with the pollen deposited area and results in pollination. They forage equally on male and female phase flowers, thereby promoting geitonogamy and xenogamy. Sometimes the bees probe the flowers laterally, bypassing the pollination apparatus, a behaviour pattern known as side-working. About 25% of the foraging visits relate to side working.

6. ***Caesalpinia nuga* Ait.** (Caesalpiniaceae): It thrives well in the estuarine habitats of Coringa and blooms during March-June. Its flowers are large, bisexual, protandrous and nectariferous, opening every morning. The flowers are aromatic, yellow with nectar guide on the upper petal, and the reproductive structures placed near the lower part of the corolla. *Xylocopa latipes* and *X. pubescens* are the principal pollinators; they are diurnal foragers and collect only nectar. Guided by the nectar guide, the bees probe the flower in upright position and contact anthers and stigma with their sternum. They exhibit traplining foraging behaviour.

7. ***Cassia alata* L.** (Caesalpiniaceae): It is a herbaceous shrub and blooms in October-February. The flowers open daily between 0300-0400 hrs. They are large, yellow, bisexual, nectarless and exhibit heteranthery, having feeding pollinating anthers with poricidal dehiscence, and enantiostyly having right and left stylar orientation. Carpenter bees are the exclusive foragers of this plant, collecting pollen by buzzing. While buzzing, the vibration of the bee causes discharge of pollen from the pollinating anthers on to the sides of the bee's thorax and abdomen. At the same time, the pollen grains are transferred to the stigmas oriented to the right or to the left. The intensity of buzzing increases with bee size, resulting in more effective pollen discharge and pollination. Heteranthery and enantiostyly, with the buzzing behaviour of pollinator carpenter bees promote cross-pollination.

8. ***Peltophorum pterocarpum* Backer ex. K. Heyne** (Caesalpiniaceae): Flowers profusely during March-June. The flowers open during daylight hours. The large, bright yellow corolla is a convenient landing site for the pollinator. Monomorphic anthers release pollen all at once,

along the entire length of the anthers, typically by complete longitudinal stomial slits, filiform style terminating in a capitate stigma lying above the stamens, and the nectar produced in traces is hidden by dense silky structures present at and around the basal parts of stamens. The flowers are promiscuous to any visitor species but carpenter bees, *Ceratina* and *Trigona* are the only foragers. Among the foraging bees, *Ceratina* and *Trigona* are small in size, and hence inappropriate for pollination. Further, they are infrequent visitors. The carpenter bees are large in size, regular and frequent foragers. They are the principal foragers, effecting pollination while probing for pollen and/or nectar. The male carpenter bees collect nectar and the females both nectar and pollen. Both sexes probe the flower legitimately for nectar. The pollen feeding females probe the flower by buzzing. After landing on the petals and/or stamens, they rapidly contract the indirect flight muscles, producing strong vibrations that are transmitted directly to the anthers, indicated by the audible buzzing of the bees. The vibrations rapidly produce a pollen cloud from the anthers, which along with the stigma, simultaneously strike the ventral side of the bee and result in sternotribic pollination. The buzzing is very brief at sunrise and gradually increases towards midday. Further, the floral vibrations are single buzzes in the morning hours, and the bees stay at one position on the flowers. Later in the day, the bees use multiple buzzes and rotate on the flowers, depending on the availability of pollen. This results in the most efficient extraction of pollen, promoting outcrossing.

9. ***Tamarindus indica* Linn.** (Caesalpiniaceae): A tall tree that has become indigenous, now commonly found in the tropics. It flowers from April to August. The small, creamy, bisexual, nectariferous flowers open each night between 2300-0400 hrs. The corolla is tubular at the base and has one small central petal rolled upwards, and two large lateral ones. The gynaecium exhibits enantiostyly. Although the flowers open at night, they are foraged by diurnal insects. The foragers include bees, ants, wasps, flies and butterflies. Of these, bees are dominant and among them, honey bees are the major pollinators while carpenter bees act as minor pollinators. Nectar gathering carpenter bees first land on the central petal in an upright position, and then insert into the tubular part of the corolla. This facilitates simultaneous contact of the sex organs with the bee's back, resulting in nototribic pollination. Although carpenter bees are minor pollinators, their inter-tree flight behaviour assumes great significance if cross-pollination of all the pollinator insects is considered.

10. ***Cochlospermum religiosum* (L.) Alston** (Cochlospermaceae): A deciduous, tropical tree, it is used commercially and for the afforestation of bare, rocky, denuded hills. After shedding leaves, it flowers during January-April. The large, showy, bright yellow, bisexual, nectarless flowers open daily from 2300-2400 hrs. The stamens are numerous and arranged in two whorls, anther dehiscence is poricidal. The style with a capitate stigma projects out from the base of the ovary and stands at the level of anthers. The flowers are foraged for pollen by carpenter bees *Xylocopa*, *Amegilla*, honey bees *Apis cerana indica, A. florea* and stingless bees *Trigona*; but only carpenter bees are regular, consistent and effective in harvesting the pollen crop. The others are occasional foragers, and play a minor role as pollinators. The carpenter bees, upon landing on the anthers, vibrate their body to discharge pollen through the apical pore of the anthers. The entire body of the carpenter bees is sprinkled with pollen, but most of the pollen is deposited on the ventral side of the bee. The pollen laden bees when foraging on the same or other inflorescences on the same plant effect geitonogamy and on flowers of different conspecific plants effect xenogamy.

11. ***Couroupita guianensis* Aubl.** (Lecythidaceae): Flowers almost throughout the

year with heavy flowering in February-March. It exhibits cauliflory. The flowers are inverted, yellow on the abaxial face and purple on the adaxial face, nectarless but produce abundant pollen. The androecium is characterized by stamens of the ring and hood which are connected by a stamen-free ligular structure. The ring stamens serve as pollinating stamina, and hood stamens as feeding stamina, exhibiting heteranthery. The stigma has a star-like fissure and becomes receptive after anther dehiscence. The flowers open daily around dawn. Their fragrance is released through osmophores present in the corolla and at the top of the filaments of the hood anthers. Carpenter bees, honey bees and the stingless bee are attracted to this fragrance. Considering their frequency, foraging behaviour, efficiency in harvesting pollen and effective pollination, carpenter bees assume principal pollinator status.

The carpenter bees, while entering the flower, push the hood down, causing the release of pollen (tetrads) that simultaneously adhere to the ventral part of the bee and are accessible for grooming. After entering the flower, they collect pollen from the hood, and during pollen collection they rub their dorsal parts against the ring anthers and the stigma, detaching several ring anthers in the process, resulting in nototribic pollination. The bees opportunistically visit the plant for pollen and other plants like *Gliricidia sepium* and *Peltophorum pterocarpum* for nectar during the same period.

12. ***Gliricidia sepium* (Jacq.) Walp** (Fabaceae): It is widely cultivated in the tropics for shade and as an ornamental tree. It sheds leaves before flowering and flowers from January to mid-March. Its flowers open between 0730-1600 hrs. The flowers are lavender, large, bisexual, odourless and nectariferous. The corolla is characteristically papilionaceous and has a light greenish-yellow glistening spot serving as a nectar guide. Stamens are diadelphous, and the style springs through the staminal tube and overarches the stamens. The flowers are visited by *Xylocopa* (Family Xylocopidae) *Trigona* (Apidae) and *Ceratina* (Anthophoridae). Xylocopid bees are large, abundant and regularly forage for nectar, while the other two bees are small, foraging occasionally for pollen and nectar. Their foraging behaviour, coupled with floral features such as spacious, strong corolla, light colour, and nectar hidden by the staminal tube, indicate that carpenter bees are the principal pollinators, while the other bees are incidental pollinators. Carpenter bees forage in sunlight. They probe the flowers in upright position and make regular contact with stamens and stigma sternotribically. The flowering trees stand out visually and appear conspicuous to the bees from a distance because of their large floral display, which enables the carpenter bees to exhibit traplining. Towards the end of the flowering period, floral density is reduced, compelling the carpenter bees to forage opportunistically on this taxon and on the nearby *Peltophorum pterocarpum* for pollen and/or nectar, and *Cassia* species for pollen, which is available at the same time.

13. ***Gmelina asiatica* Linn.** (Verbenaceae): A deciduous, perennial, straggling shrub, flowering from March-October. The flowers open between 0500-0600 hrs every day. They are large, yellow, bisexual and nectariferous. The corolla is tubular at the base and its free end is inflated into a bilipped bell-like structure with the upper lip enlarged and the lower lip with a large central lobe and two small lateral lobes. Stamens are didynamous and epipetalous. The stigma is simple and stretched beyond the anthers. The flowers are foraged exclusively by day-foraging bees, e.g. *Xylocopa*, *Amegilla*, *Trigona* and *Ceratina*. Effective pollination in this shrub is by carpenter bees, which forage for nectar only. They approach the flower in upright position, land on the lower corolla lip and crawl into the tubular part, stretching their proboscis to full length. In doing so, the dorsal surface of their

body makes initial contact with the stigma and then with the dehisced anthers, effecting nototriby. If the bees carry on their back conspecific pollen from previously foraged flowers, they effect cross-pollination by their initial contact with the stigma. The other bees are of no use to the plant as pollinators, but nectar depletion by *Amegilla* indirectly forces carpenter bees to pay multiple visits to the flowers to satisfy their energy requirement. Further, the carpenter bees exhibit traplining, which promotes cross-pollination.

14. ***Martynia annua* L.** (Martyniaceae): An annual that normally flowers during July-October. Flowers open everyday between 0400-0500 hrs. The flowers are large, showy, bisexual and nectariferous. The corolla is pendant and tubular, with its mouth containing nectar guides directed laterally. The stamens are epipetalous, with syngenecious anthers. The style with bilobed stigma overarches the anther. Flowers are foraged by carpenter bees, digger bees and hawkmoths during the day. The hawkmoth is an inefficient pollinator, but may compel the bees to make multiple visits to the flowers by depleting nectar. The two bee species are equally efficient in pollination of the taxon. While probing the flowers, they land on the large lip and penetrate into the corolla tube following the nectar guides. In doing so, their dorsal side touches the sex organs and pollination results.

15. ***Moringa oleifera* Lam.** (Moringaceae): Popularly known as the drumstick tree, it thrives best under a tropical insular climate. The tree is valued for the tender pods used as vegetables. This tree blooms twice a year, during February-May and again during September-November; the former blooming is more intense. The flowers open between 0500-0900 hrs. They are creamy white, large, showy, bisexual and nectariferous. They are foraged by a variety of insects but carpenter bees and digger bees are the main pollinators. Even among these, carpenter bees are the most appropriate for manipulating the flower. Carpenter bees gather only nectar; while doing so, they alight on the reflexed petals and probe for nectar during which the sex organs brush against their dorsal side, effecting nototriby. They travel long distances to forage on widely dispersed conspecific plants. This inter-tree movement promotes xenogamy. The bees are also opportunistic in that they use other nectariferous plants in the study area.

Discussion and Conclusions

Most of the plant species described are zygomorphic, large, showy and bisexual; some have long tubes and others short, all perfectly adapted to pollination by carpenter bees. Species with the sex organs placed near or along the upper lip are adapted to nototriby. *Caesalpinia* and *Gliricidia* have their sex organs in the lower part of the corolla and are adapted to sternotriby. The anthesis timings in different plant species are different, some at night, others during the day and one, i.e. *Alangium*, both day and night; but the flowers of all the species are foraged diurnally. *Anisomeles* and *Acanthus* are foraged by insects as well as sunbirds. *Caesalpinia* and *Cassia* are outcrossers, exclusively foraged and pollinated by carpenter bees. Some plant species are foraged by different groups of insects and others exclusively by bees, but carpenter bees are the main pollinators, also *Amegilla* for *Martynia* and sunbirds for *Acanthus* and *Anisomeles*. Carpenter bees effect pollination through nototriby and sternotriby; the former is a more advanced mechanism in which pollen deposition is very precise and not accessible for grooming by the bees. It ensures pollination success, while in sternotriby, pollen wastage takes place during grooming of the bee and in flight, and is thus not economical.

Carpenter bees exhibit buzzing behaviour while collecting pollen of the nectarless *Cassia* and *Cochlospermum*, in which anther dehiscence is poricidal, and of *Peltophorum* flowers with

longitudinally dehiscent anthers. Buzzing is typical in pollinators of poricidal flowers that exhibit heteranthery and enantiostyly as in *Cassia,* or without these devices as in *Cochlospermum* (Buchmann 1983), while *Peltophorum* with firmly adhered oily pollen is also buzz-pollinated. On some plant species, the carpenter bees exhibit territoriality or traplining or both, and on others, opportunistic foraging behaviour. Territoriality means that the bees select a population of flowers rich in nutrients, usually from one plant species, and obtain food within the same population throughout the flowering season. When exhibiting territorial behaviour, male bees alternately defend the selected flower population by chasing away intruders and forage on the flowers. Traplining is a foraging behaviour in which bees make long distance flights and remember images of the whole region visited on their regular rounds. Opportunistic behaviour is when the bees exploit floral resources, mainly nectar, from the flowers of various plant species co-occurring and blooming simultaneously, in order to obtain forage for themselves and for their offspring (Pijil 1954, Janzen 1964, Frankie 1976, Barrows 1980, Frankie *et al.* 1983, Aluri and Subba Reddi 1989). Of these types of behaviour, territoriality and traplining impose fidelity in bees to remain faithful to one flowering plant species, greatly promoting outcrossing, whereas opportunistic behaviour facilitates the use of available flowering species in the biotope, depending on the floral density or intensity of flowering.

All the plant species except *Cassia*, *Cochlospermum* and *Couroupita* are nectariferous, with nectar volumes ranging from 0.8 to 80 μl and sugar concentrations from 5 to 48% (authors' data). The foraging of carpenter bees on these plant species indicates that they make use of variously concentrated sugars as available at different times of the year for their sustenance. Nectarless plant species provide pollen rich in nutrients to carpenter bees. The floral structural and functional devices, coupled with variously coloured corolla: yellow, purple, creamy-white, sometimes lavender, are evolved for foraging by carpenter bees exclusively or preferentially.

Both plants and carpenter bees mutually benefit each other, and thereby ensure perpetuation of both in their respective biotopes. There is unequivocal evidence of the importance of carpenter bees in the reproduction of different species of plants, and thus for the production of plant biomass of terrestrial ecosystems, and for generating and maintaining genetic diversity of the plants.

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DIVERSITY AND SPECIES-ABUNDANCE DISTRIBUTION OF BIRDS IN THE TROPICAL FORESTS OF SILENT VALLEY, KERALA[1]

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(*With three text-figures*)

Key words: Diversity, species-abundance, Silent Valley, Kerala

Diversity and species-abundance distribution of birds was studied in the evergreen and moist deciduous forests of the Silent Valley, Kerala. The study was carried out from May 1988 to April 1993. Line transects were employed to census the birds. A total of 137 taxa of birds were recorded from the study area. Diversity index of birds in the evergreen forests of Silent Valley and moist deciduous forests of Mukkali was 3.45 and 3.30 respectively (Shannon-Wener Index). Species-abundance models followed truncated log-normal distribution in both the vegetation types, which indicated the absence of a single dominant species, or group, and the presence of a long series of species, with few individuals. Similarity indices showed that the two areas were similar in the composition of bird communities only at 40% level. More species with low numbers of individuals were found in the evergreen forests of Silent Valley than in the moist deciduous forests of Mukkali. Evaluation of the area showed the rich and undisturbed bird community at Silent Valley and Mukkali, which is comparable to tropical forests of other countries. Considering this, it is recommended that this area be added to the existing Silent Valley National Park.

INTRODUCTION

Avian community studies are effective tools for monitoring a forest ecosystem. Evaluating bird communities of the Western Ghats to plan for biodiversity-friendly development is gaining significance (Pramod *et al.* 1997). The Silent Valley National Park was established in September 1986. It occupies an area of 90 sq. km. The adjacent forest areas, starting from Mukkali to the abandoned dam site, are not included in the National Park; it only has the status of a reserve forest. Considering this, there was a proposal to declare the forests from Mukkali up to Silent Valley National Park as a Wildlife Sanctuary, to function as a buffer zone for the National Park. A study was thus undertaken to determine the diversity and species-abundance distribution of birds in the forests adjacent to the Silent Valley National Park. Ramakrishnan (1983) examined several parameters of the bird communities in the forests of northern Kerala. Diversity and community structure of birds were also studied by Johnsingh *et al.* (1987), Johnsingh *et al.* (1994), Katti (1989), Daniels (1989, 1996, 1997), Gokula and Vijayan (1996), and Sundaramoorthy (1991). Diversity of tropical forest birds has been studied in South America and in many other countries. Similar studies in other regions examined the structure of forest bird communities (Terborgh *et al.* 1990), distribution (Howe *et al.* 1981) and community organisation (Landers and Mac Mahon, 1980).

STUDY AREA

The study area is located in Palghat district, Kerala State, from 11° 3' to 11° 13' N and 76° 25' to 76° 35' E, in the Western Ghats of southwestern India, comprising the Silent Valley

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and Mukkali Reserve Forest (*JBNHS 97(1)*: 53, Fig. 1.) Two study sites were selected — one was near the abandoned dam site at Silent Valley, with tropical evergreen forests, and the other at Mukkali, with moist deciduous forests. The elevation varies from 500 to 1,500 m above msl and the topography is undulating. Silent Valley and Mukkali fall under the Malabar Rain Forest Realm of Udvardy (1975). According to Rodgers and Panwar (1989), the area falls under the biogeographic zone 5 Western Ghats, and Biogeographic Province 5B Western Ghats mountains, and Biogeographic Subdivision Nilgiri.

There are two distinct seasons in the study area, the monsoon from the end of May to the middle of November, and the dry summer season from December to the first half of May. Compared to Silent Valley (5,096 mm/year), mean annual rainfall was less at Mukkali (4,227 mm/year). Temperature was high at Mukkali, varying from 21 °C in January to 27 °C in April. Pascal (1988) described the vegetation of the Silent Valley as *Cullenia exarillata - Mesua ferrea - Palaquium ellipticum* type, characterised by an abundance of these three species, which may constitute about 80% of the large trees. Degraded areas and other vegetation types, like grasslands, are also found here. Vegetation of the Mukkali area is Southern Secondary Moist Mixed Deciduous Forest (Champion and Seth, 1968).

Methods

Census methods: Variable width line transects method was adopted for this study (Burnham *et al.* 1981). Whenever a bird was spotted, the species was identified and details like the number of birds and perpendicular distance from the transects were noted (Ali and Ripley 1983a, Ali and Ripley 1983b, Ali 1969). Perpendicular distances were assessed approximately up to metres. To assess the distances, known distances were measured and marked on trees, using a Range Finder, before the census. Two line transects, each 4 km in length, were selected, one at Silent Valley and the other at Mukkali. The first transect covered representative habitats of the area like evergreen forest, small patch of grassland, and fire burned evergreen forest. The second transect covered moist deciduous forest. Along this transect, some rocky patches were also seen, and some areas had a history of fire, 10 years ago.

Census was started 30 minutes after sunrise in all the months. The distance of 4,000 m was covered within a fixed duration of 120 minutes, i.e. 33 m/minute. On rainy days, 150 minutes were spent on completing each transect. No census was done on days with heavy rain and fog. Two samples were collected from each area in a month. Altogether, 150 samples were collected from the study area, between May 1988 and April 1993. Among these, 80 samples were from Silent Valley and 70 from Mukkali, collected over 45 months. There was a gap of 8 months from May 1991 to December 1991 in the collection of data.

Abundance and density: The total number of birds seen in each month in two vegetation types was calculated using the census data. Similarly, the density of birds in each area, and individual abundance of selected species, were also calculated.

The Fourier series method was used for analysis, and the density was computed from ungrouped, perpendicular distances from transects. All the assumptions described by Burnham *et al.* (1981) were followed during the census. The density was computed using the software TRANSECT. Ungrouped data was used for analysis. A flock of birds was considered as a single individual, and only one perpendicular distance to the middle of the flock was measured. The actual density was calculated by multiplying density of flocks with the mean flock size. A bird call was considered to be equivalent to a single

individual, and was used, along with sighting records, for density estimation. The total bird density was calculated for each month by pooling the data of all the species. Species richness indices like Margalef index and Menhinick index were calculated for both sites, using the formula described by Magurran (1988). Since the sample sizes from the two areas are not equal, rarefaction using Hurlbert's (1971) formula was done. The standardised sample size (n) is taken as the total number of birds observed at Mukkali (2,628), which is the smaller of the two.

Species-abundance models: Species-abundance models were constructed as explained in Magurran (1988). Species of birds were ranked in order of abundance, as represented by individuals seen for each species, and this was plotted in decreasing order for all species against the number of individuals for the two areas. Truncated log-normal distribution was fitted to species-abundance data, using maximum likelihood estimation (Slocomb *et al.* 1977).

Diversity indices: Shannon-Wener index, Simpson's index and Hill's diversity numbers N1 and N2 were calculated for Silent Valley and Mukkali, using the program SPECDIVERS.BAS developed by Ludwig and Reynolds (1988). Similarly, evenness was also calculated using the same program. Similarity indices between the two areas were calculated using Jaccard index, Sorenson index and modified Sorenson quantitative (Magurran 1988). In order to find out whether any significant difference existed in the bird diversity between the two places, a 't' test was done using Shannon-Wener index, by the Magurran method (1988). Jack-knifing of diversity index was not attempted, since the two diversities showed significant difference.

RESULTS

Abundance and density: A total of 137 taxa of birds were recorded from the transects. Out of these, 21 species were migrant at Silent Valley and 11 at Mukkali. Silent Valley is not a major wintering area of palaearctic migrants and most of the birds show only local movements. No wintering waterfowl were recorded from the area. The migrants recorded here were wagtails (*Motacilla* sp.), common rosefinch (*Carpodacus erythrinus*) and redwinged crested cuckoo (*Clamator coromandus*). The mean number of birds seen each month over the years is presented in Table 1. The lowest number of birds recorded at Silent Valley was 43 and the highest 153. At Mukkali, it was 41 and 78 respectively. A slight reduction in the total number of birds was seen during the monsoon. Chi-square test was done for both study sites to find out if any significant difference existed in the total number of birds in various months. Results showed significant difference for the Silent Valley ($X^2 = 131.09$; $P = 0.001$; df = 11) and Mukkali ($X^2 = 28.69$; $P = 0.01$; df = 11).

Mean monthly density of birds in each month over the years is presented in Fig. 1. maximum bird density was found in December and minimum in August, at Silent Valley. At Mukkali, lowest density was found in July and highest in September. Mean density of birds during the study period was 1,122 birds/sq. km,

TABLE 1
MEAN NUMBER OF BIRDS RECORDED IN EACH MONTH (1988-1993) (N=150)

	Months											
Area	J	F	M	A	M	J	J	A	S	0	N	D
Silent Valley	91	87	70	65	76	43	46	47	95	81	109	153
Mukkali	66	54	77	52	49	66	43	51	68	58	78	41

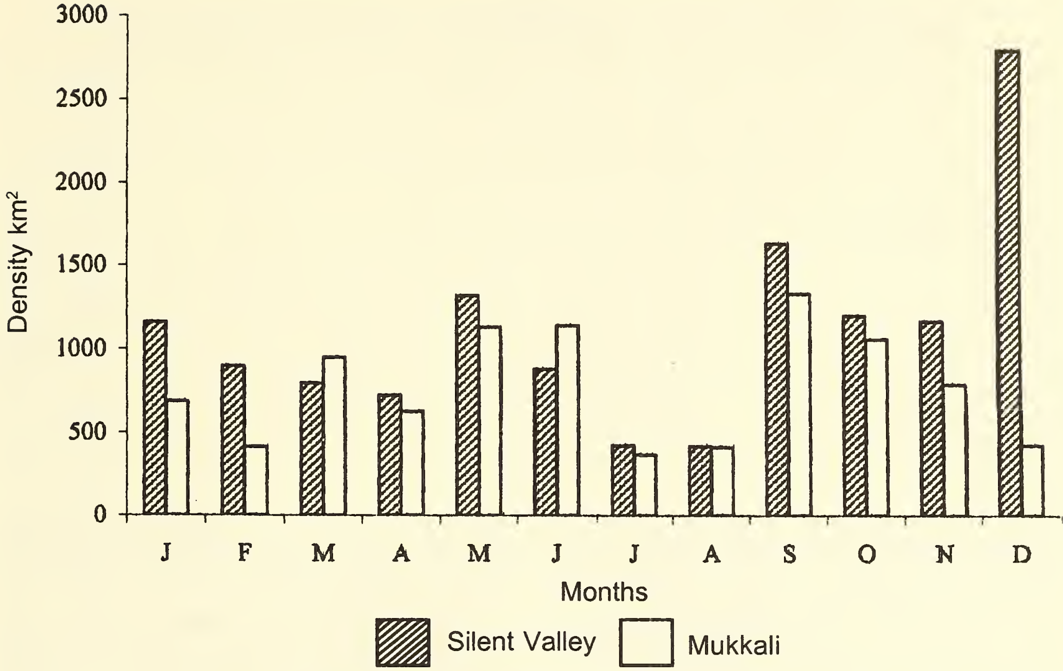

Fig. 1: Density of birds in each month at Silent Valley and Mukkali (1988-1993)

at Silent Valley and 780 birds/sq. km, at Mukkali.

Individual species abundance: Out of the 99 and 96 species observed at Silent Valley and Mukkali respectively, the monthly abundance of each of 10 commonly observed species was calculated (Tables 2 and 3). The birds of Silent Valley can be grouped into two, based on the difference in abundance over months. The first group of resident birds showed an almost stable abundance, while the second group registered an increase in abundance in summer. The first group

TABLE 2
MEAN MONTHLY ABUNDANCE OF SELECTED BIRDS AT SILENT VALLEY, 1988-1993 (N=150)

	Months											
Species	J	F	M	A	M	J	J	A	S	0	N	D
Black bulbul	3	5	3	4	1	-	-	-	4	-	23	36
Pied bushchat	3	3	4	3	3	2	2	2	2	1	2	6
Goldenbacked woodpecker	1	1	2	1	1	0	1	1	1	2	3	1
Grey junglefowl	3	2	2	1	-	-	-	1	2	2	1	1
Hill myna	6	8	5	6	5	1	-	-	14	1	7	8
Malabar whistling thrush	1	1	1	2	3	1	2	1	0	2	1	1
Redwhiskered bulbul	1	3	4	2	4	0	1	0	3	7	1	1
Small green barbet	2	5	4	2	1	0	0	1	2	4	6	6
Southern treepie	1	0	1	1	3	1	1	0	0	2	1	2
Yellowbrowed bulbul	13	13	9	12	16	19	16	14	18	16	12	12

- not recorded

TABLE 3
MEAN MONTHLY ABUNDANCE OF SELECTED BIRDS AT MUKKALI, 1988-1993 (N=150)

	Months											
Species	J	F	M	A	M	J	J	A	S	0	N	D
Black drongo	2	3	5	1	3	4	4	-	3	3	3	4
Blossomheaded parakeet	4	3	1	1	-	-	-	-	1	6	6	3
Goldenbacked woodpecker	2	2	1	1	1	2	1	-	1	1	1	-
Jungle babbler	7	7	11	11	8	13	10	12	13	10	1	4
Magpie-robin	1	2	1	2	1	1	-	-	2	-	-	-
Racket-tailed drongo	1	1	2	1	2	4	1	2	2	1	2	2
Redvented bulbul	2	1	4	3	2	2	3	1	3	1	3	2
Small green barbet	4	4	6	5	1	2	1	-	1	1	3	1
Spotted dove	3	2	2	1	-	-	1	-	1	2	1	-
Yellowbrowed bulbul	2	1	2	1	-	2	3	3	1	2	3	2

- not recorded

comprised of grey junglefowl (*Gallus sonneratii*), Malabar whistling thrush (*Myiophonus horsfieldii*), southern treepie (*Dendrocitta vagabunda*), yellowbrowed bulbul (*Hypsipetes indicus*), small green barbet (*Megalaima viridis*) and pied bushchat (*Saxicola caprata*).

The second group comprised of black bulbul (*Hypsipetes madagascariensis*), parakeets (*Psittacula* spp.), doves (*Streptopelia* spp.) and pigeons (*Treron* spp.) which showed an increase in number during summer, and a decrease during monsoon, while in June and July they were absent. The small green barbet, roseringed parakeet (*Psittacula krameri*) and the blossomheaded parakeet (*P. cyanocephala*) showed maximum density during the dry months at Mukkali. Compared to the Silent Valley, the overall abundance of birds (Table 3) was lower (in both seasons) at Mukkali and higher during winter. Certain species showed consistent abundance in both areas. The abundance of the yellowbrowed bulbul was stable at Silent Valley, while that of the redvented bulbul (*Pycnonotus cafer*) and small green barbet was stable at Mukkali.

Species richness indices: Margalef index and Menhinick index showed higher values for Mukkali (12.18 & 1.89) and lower values for Silent Valley (11.40 & 1.35). Rarefaction showed that the expected number of species at Silent Valley would be 83.

Species-abundance models: Another way of describing diversity in a community is through species-abundance or distribution models introduced by Fischer *et al.* (1943). A species-abundance model utilizes all the information gathered in a community, and is the most complete mathematical description of the data (Magurran, 1988). Species-abundance distribution of Silent Valley and Mukkali in semi-log scale is presented in Figs. 2 and 3. This distribution indicates the absence of a single dominant species or group of species, and the presence of a long series of very rare species at Silent Valley and Mukkali. (Species represented by less than 2% of individuals recorded are termed as rare: Magurran, 1988). The observed and expected number of species was compared using X^2 goodness of fit test. The test showed no significant difference between the observed and expected distribution. This indicated that the distribution pattern follows truncated log-normal ($X^2 = 8.63$; $P = 0.30$) at Silent Valley. At Mukkali also, the distribution pattern was a truncated log-normal distribution ($X^2 = 9.67$; P 0.16).

Diversity indices: Values of four diversity

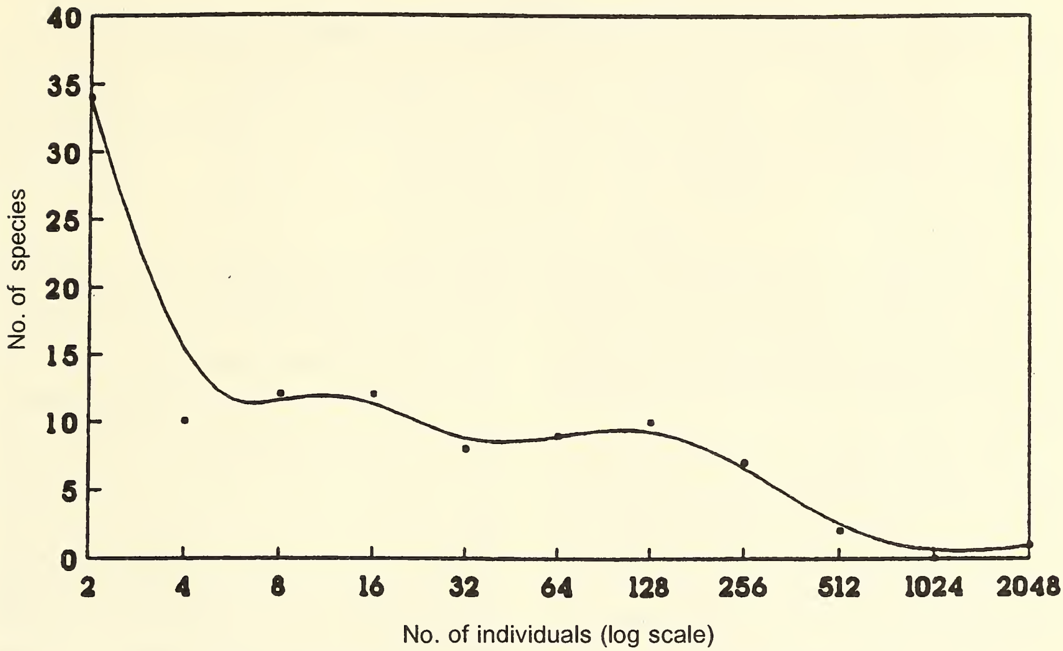

Fig. 2: Species-abundance distribution of birds at Silent Valley

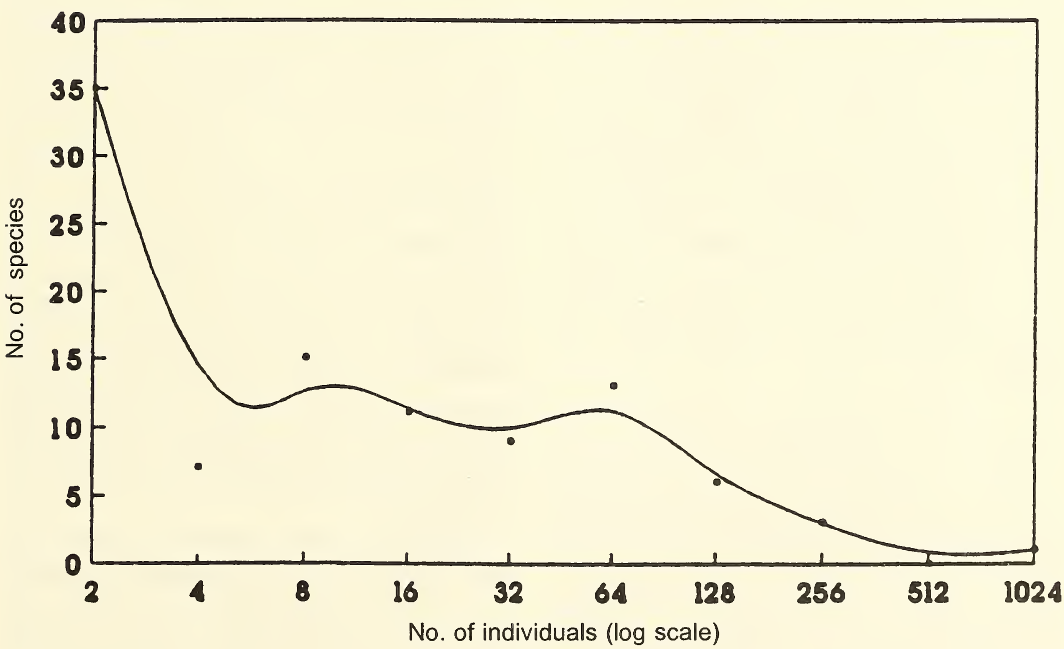

Fig. 3: Species-abundance distribution of birds at Mukkali

TABLE 4
BIRD SPECIES DIVERSITY IN THE STUDY AREA, 1988-93 (N=150)

	No. of species	No. of individuals	Simpson's Index	Shannon Wener Index	Hill's Number N1	Hill's Number N2
Silent Valley	99	5412	0.07	3.30	27.14	14.54
Mukkali	96	2641	0.06	3.45	31.38	15.67

indices obtained for Silent Valley and Mukkali are given in Table 4. A higher diversity index was obtained at Mukkali. Significant difference was obtained in the diversity of the two study sites from the 't' test ($t = 4.7734$; $P = 0.05$; df 6,094).

The values of evenness measures showed higher evenness at Mukkali (0.75) than Silent Valley (0.72). Value of Jaccard index (Cj) was 0.40 and Sorenson index (Cs) was 0.57. The computed similarity indices showed medium similarity between the two study sites. Out of the 137 species recorded in the two areas, only 56 species were common to both sites. One disadvantage with the above indices was that they do not consider abundance data. Instead, the presence of abundant and rare individuals is given equal consideration. Similarity measures based on quantitative data solved this problem. Modified Sorenson quantitative was such a measure, and the computed value was Cn = 0.44. Of the three similarity indices computed, Jaccard and Sorenson quantitative shows a similarity above 40% and the Sorenson index shows a similarity of 57% between Silent Valley and Mukkali.

DISCUSSION

The total number of birds sighted each month showed significant difference between Silent Valley and Mukkali. In December, there was substantial increase in the density and number of birds. Similarly, Morrison *et al.* (1980) also reported reduction of birds during the non-winter period and their increase during winter. One factor influencing the abundance is detectability. Seasonal differences in detectability are common for most of the bird species (Emlen, 1971). These differences result from changes in weather and habitat structure. Increasing foliage density decreased the visibility of birds. But in the study area, foliage abundance was identical in all seasons in the evergreen forests of Silent Valley, and there was a reduction in foliage abundance in the moist deciduous forests of Mukkali during summer (Jayson 1994). Rainfall had some influence on detectability in both the vegetation types. The higher density of birds observed in Silent Valley and lower density in Mukkali indicate the ability of tropical evergreen forest to harbour more birds than moist deciduous forest. The number of individuals per sq. km is comparable to tropical forests of other countries (Table 5). The grey junglefowl, Malabar whistling thrush, southern tree pie and yellowbrowed bulbul showed a stable population, while the black bulbul, doves and pigeons showed an increase in population during summer at Silent Valley. The rest could have moved out due to rainfall and changes in prey abundance. The differences in abundance of these two groups, caused due to local movement, may enable them to cope with the resource availability and climatic conditions. Of these, the black bulbul is a known local migrant.

Species richness in an area is dependent on the availability of food, climate, evolutionary history, and predation pressure. Species richness indices and diversity indices showed high diversity for Mukkali. This is a moist deciduous forest with human interference. It is likely that

TABLE 5
COMPARISON OF PRESENT STUDY WITH SIMILAR STUDIES IN OTHER TROPICAL COUNTRIES

Country/Area	No. of species	Density	Vegetation	Source
Silent Valley (India)	99	1,122 birds/sq. km	Tropical Evergreen	Present study
Mukkali (India)	96	780 birds/sq. km	Tropical Moist deciduous	Present study
Panama	-	1,820 birds/sq. km	Tropical Evergreen	Karr (1971)
(French) Guiana	263	1,520 birds/sq. km	-	Thiollay (1986)
Gabon	364	3,690 birds/sq. km	Rainforest	Brosset (1990)
New Guinea	-	3,450 birds/sq. km	Lowland rain forest	Bell (1983)
Amazon	245	1,910 birds/sq. km	-	Terborgh *et al.* (1990)

the colonisation by man has diversified the food resources available to birds. Another reason, to which the high diversity at Mukkali can be attributed, is the availability of varied microhabitats.

Many rare species of birds occur at Silent Valley and Mukkali, which is typical of tropical forests (Lovejoy, 1975). The factors which control the species richness in an area are broadly divided into historical and ecological (Giller, 1984). Among the historical factors, speciation and crossing of geological barriers, and supply of colonists are more important. Among the ecological factors, mortality due to predation is important, and many such cases were recorded from both the areas.

Currently, many models are available for describing species-abundance distribution and some of them are geometric series: the log-normal, the log series and MacArthur's Broken-stick model. Preston (1948) introduced the log-normal distribution to explain the species-abundance data. Usually in ecological work, distribution of species is always truncated at the left side (Preston 1962). Geometric series patterns are usually found in species-poor or harsh environments. Log-series patterns aie usually observed where one or a few factors dominate the ecology of a community. Log-normal distribution is found in most biological populations. The Broken-stick model distribution shows the maximum equitable distribution of available resources. Species-abundance distribution at Silent Valley and Mukkali follows the truncated log-normal model. The Amazonian forest bird community also showed log-normal distribution in species-abundance (Terborgh *et al.* 1990). As in the case of birds, species-abundance of ants in Kobbeduinen and Kooiduinen approximately agreed with log-normal distribution (Boomsa and Van Loon 1982). This clearly explains the existence of an undisturbed bird community in both the areas.

Diversity indices are dependent on two factors, species richness and evenness. Considerable discussion is on about the measurement of diversity, which is directly correlated with the stability of the ecosystems, being higher in biologically controlled systems, and lower in polluted ecosystems (Rosenberg 1976). But some authors like Hurlbert (1971) even consider diversity indices as a 'non-concept'.

Higher diversity indices were obtained for Mukkali than for Silent Valley. As the microhabitats were diverse at Mukkali, they naturally support a more diverse bird community. Similarly, there was slightly higher evenness at Mukkali. This is also natural, as tropical wet evergreen forests support more rare species than other habitats. Similar observations have been reported by Pearson (1977). As the evenness measures show high values, it can be concluded that species are uniformly represented by individuals at Mukkali.

A number of hypotheses have been made to explain the characteristic diversity profiles of different habitats. Habitat heterogeneity, in addition to area, is an important determinant of species richness (Boecklen and Simberloff 1986). Habitat factors such as tree density, basal area, number of tree species, percent ground cover, percent canopy cover and canopy height, are also important in determining diversity. Habitat heterogeneity at Mukkali may be one of the factors causing the higher diversity recorded.

Diversity indices are extensively used in environmental monitoring and testing, and in conservation. As the objective of world conservation strategy is to maximise diversity of habitats, these indices are extensively used to monitor and evaluate habitats. According to Usher (1986), diversity is the most frequently adopted criterion for evaluation of conservation schemes. Diversity indices are directly correlated with the stability of the ecosystem and will be high in biologically controlled systems, as seen at Silent Valley and Mukkali. All diversity indices have limitations because they attempt to combine a number of variables that characterise community structure. The evaluation of the area shows the rich and undisturbed species diversity of birds at Silent Valley and Mukkali, which is comparable to other tropical forests. It is recommended that the forests from Mukkali up to the National Park be declared as a protected area, to function as a buffer zone for the Silent Valley National Park.

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NEW DESCRIPTIONS

A NEW SPECIES OF *ACHLYA* (PHYCOMYCETES) FROM RIVERINE WATERS[1]

R.V. Gandhe and M.J. Desale[2]

(*With one text-figure*)

Key words: Riverine fungi, Aquatic phycomycetes, *A. punensis* sp. nov.

Aquatic fungi were isolated from riverine waters for extensive studies. The genus *Achlya* was found dominant with 14 species. *Achlya punensis* is proposed as a new species and compared with allied species.

Introduction

During our extensive studies on the riverine aquatic fungi for the last three years, 11 genera and 35 species were isolated from the rivers Mula and Mutha, Pune, Maharashtra State, India. The species of Saprolegniaceae, Blastocladiaceae and Peronosporaceae were most frequent in their occurrence and dominance throughout the year. The genus *Achlya* dominated among all the genera with its 14 species. The taxon proposed here as a new species of *Achlya*, *A. punensis,* is close to *A. conspicua* in some characters, but differs drastically in several important characters.

Material and Methods

Preliminary survey of the rivers Mula and Mutha was carried out for selection of suitable water sampling stations. The water sampling stations were established on both the rivers for collecting the water samples regularly every fortnight. Aquatic fungi were isolated from different water samples by baiting technique (Butler, 1907).

Achlya punensis R.V. Gandhe and M. J. Desale sp.nov. (Figs 1-9)

Growth in culture moderately dense, developing in 1 to 2 cm colony on baits within a week. Hyphae stout at the base up to 71.0 µm thick, with average hyphal thickness ranging from 14.2 to 56.6 µm, tapering at the free ends, sparingly branched.

Zoosporangia abundant, terminal, cylindrical to slightly broader than hyphae, sometimes filiform, 14.2 to 42.6 µm x 142 to 511.2 µm. Zoospores spherical, 12.8 µm in diameter, liberated achlyoid type, forming clumps at the exit pore for a short time, thereafter settled at the bottom.

Gemmae distinctly swollen, mostly terminal or intercalary, often segmented, elongated, functioning as sporangia, or bearing sex organs, sometimes irregularly branched. Oogonia abundant, spread over the entire culture, from the basal hyphae to the free ends, spherical, 34.22 to 96.6 µm in diameter, mostly 49.9 to 56.0 µm in diameter, borne on short stalks, sometimes stalks slightly longer than the diameter of the oogonia. Eggs 1 to 6, mostly 2 to 4 per oogonium, 28.08 to 34.32 µm in diameter, eccentric, with a single large oil drop at maturity 15.6 to 18.7 µm in diameter, immature eggs contain many small oil droplets. Oogonial wall unpitted, but sometimes inconspicuously pitted at the contact portion of the antheridium.

Antheridia abundant, mostly monoclinous, androgynous, often with a long slender stalk, very rarely diclinous, antheridial branches usually developed from the main hyphae, antheridia on all the oogonia, at least 2 to 3 antheridia per oogonium, developing conspicuous foot-like projections, penetrating into oogonia.

Isolated from the rivers Mula and Mutha

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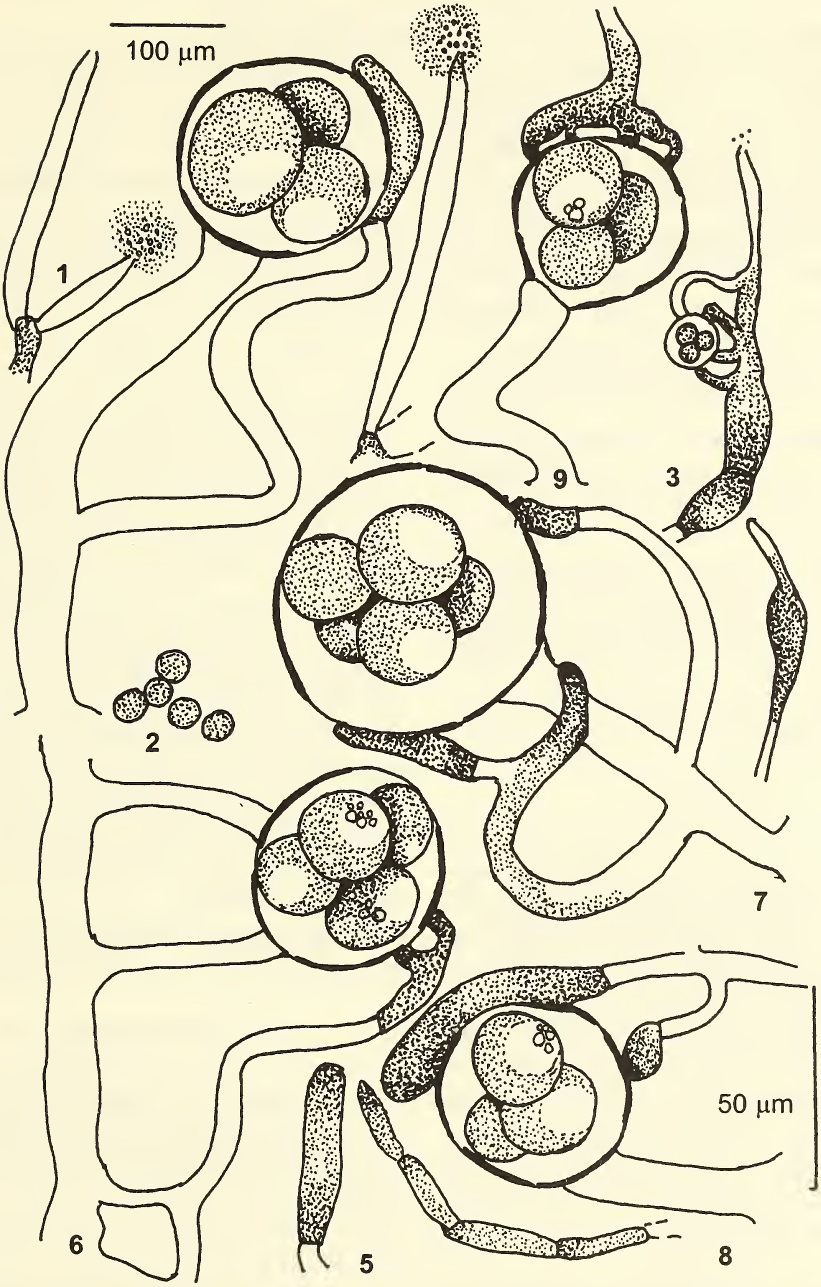

Fig. 1-9: *Achlya punensis* Gandhe and Desale sp.nov. 1. Terminal typical sporangia, 2. Zoospores, 3. Gemma developing into oogonium and monoclinous antheridia; note terminal sporangium, 4. Very long stalked oogonium with monoclinous androgynous antheridium. Note the antheridial cell projections, 5. Segmented and rod shaped gemmae, 6. Oogonium showing monoclinous antheridia, 7. Oogonium with monoclinous androgynous branched antheridia, 8. Oogonium with diclinous antheridia, 9. Oogonium with curved stalk and diclinous antheridium.

July 1995, Pune, Maharashtra, India.

Latin Diagnosis: Mycelium densum; hypis ramosis porrectis us que ad 1-2 cm in diametrum; hyphis primariis in basi 71.0 μm dim; sporangiis copiosis, longa, cylindrica, 14.2-42.6 μm x 142-511.2 μm; Zoosporiis 12.8 μm in diametrum, apice dehiscentibus et rectis; Ejectio sporarum typica generis. Gemmae copiosae, variis, plerumque in a equaliter formatis. Oogoniis copiosis, et globosis, 34.22-96.6 μm in diametrum, natis ex primariis hyphis in ramulis lateralibus.

Oosporiis numero 1-6, plerumque 2-4, 28.08-34.32 μ in diametrum, excentricis guttulis aleosis excentricis dispositis, 15.6-18.7 μ in diametrum.

Antheridis copiosis, monoclinobus out androgenibus, persistentibus, antheridio digitalibus prominentiis affixo, 2-3 pro quoque oogonio.

Hab. ad terram humosam in rivi Mula, Mutha, July 1995.

Discussion

The present species showed some resemblance to *Achlya conspicua* Coker (1923), especially in the case of monoclinous and androgynous antheridia and eccentric condition of oospores in the oogonium. However, it differs drastically from *A. conspicua* in several other important characters such as hyphal thickness, sporangial diameter, oogonial oospore number and diameter, and frequently developed antheridial branches. The basal hyphae in the present species are not stout as in *A. conspicua* but sometimes reached up to 71.0 μm and were sparingly branched. Zoosporangia in the present isolate were larger than that in *A. conspicua* and were often borne at the tip of the gemmae, which functioned as zoosporangia. The most striking feature of the present species is the development of sex organs, both antheridia and oogonia, from the gemmae or the stalk of the gemmae. This unusual pattern was not observed in *A. conspicua* or in any other allied species of *Achlya*. Oogonia in the present species were abundant, spherical and 32.32 μm x 93.6 μm in diameter, whereas oogonia were moderately abundant, spherical to oval, 45 μm to 120 μm in diameter in *A. conspicua*. The number of oospores was also very high, up to 40 in *A. conspicua,* which was much less, only 1 to 6, in the present species. The species described has monoclinous, androgynous, antheridial branches, which are longer and more frequent than in *A. conspicua* and other known allied species of *Achlya* (Coker 1923, Johnson 1956, Sparrow 1960). All the above mentioned characters certainly set apart this species from *A. conspicua* and other allied species. We, therefore, propose a new species of *Achlya*, and name it *A. punensis*.

Etymology: The species is named *punensis* as it was collected from a river in Pune.

Acknowledgements

We thank the Principal, Modern College, Pune, for encouragement and the Head, Botany Department, for providing laboratory facilities.

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THREE NEW SPECIES OF PTEROMALIDAE (HYMENOPTERA: CHALCIDOIDEA) FROM INDIA[1]

P.M. SURESHAN[2] AND T.C. NARENDRAN[3]

(*With fifteen text-figures*)

Key words: Hymenoptera, Chalcidoidea, Pteromalidae, *Cryptoprymna, Toxeumorpha*, new species

Three new species of Pteromalidae (Hymenoptera : Chalcidoidea), namely, *Cryptoprymna elongata*, *C. indiana* and *Toxeumorpha minuta* from India are described and illustrated. A key to the species of *Cryptoprymna* from India is provided.

INTRODUCTION

The paper deals with the descriptions of three new species of Pteromalidae collected from Kerala, India. The genera *Cryptoprymna* Forster and *Toxeumorpha* Girault, to which the new species are assigned, are being reported here for the first time from India.

Terminology followed in this paper is based on Graham (1969). In addition, the antennal funicular segments are numbered from F1 to F6 and the gastral tergites from T1 to T6, beginning with the first after petiole and the last before epipygium. The following abbreviations are used: Ocellar ocular distance OOL, Posterior ocellar distance POL, Submarginal vein SMV, Marginal vein MV, Post-marginal vein PMV, and Stigmal vein STV.

The types are deposited in the collection of the Zoological Survey of India, Calicut.

Genus *Cryptoprymna* Forster

Prosodes Walker 1833: 371, 374.

Type species: *Prosodes ater* Walker, preoccupied by *Prosodes* Eschscholtz 1829.

Cryptoprymna Forster 1856: 52, 56, 59. Replacement name for *Prosodes* Walker.

Cryptoprymnus Thomson 1878: 17, 22. Cresson 1887: 75 (key). (Invalid emendation).

Polycystelomorpha Girault 1915 (a): 340. Type species *Polycystelomorpha flavifemur* Girault, by original designation, Boucek 1988: 467: synonymy.

The genus contains six described species *C. atra* (Walker 1833) and *C. dixiana* (Heydon 1988) from Nearctic, *C. africanus* (Boucek 1976) from Southern Africa, *C. brama* (Motschulsky 1863) from Southern Asia, *C. crucigera* (Boucek 1988) from Papua New Guinea and *C. australiensis* (Girault 1913) from Queensland. Two new species *C. elongata* and *C. indiana* are being added here to the genus from India.

KEY TO INDIAN SPECIES OF *CRYPTOPRYMNA* FORSTER

1. Antenna (Fig. 2) slender, with F1 as long as F2, scape a little longer than eye, clava 2x as long as wide; MV length 1.3x PMV; gastral petiole (Fig. 1) slender, length 2.9x width .... *elongata* sp. nov.

   Antenna (Fig. 8) stout with F1 shorter than F2, scape little shorter than eye, clava 1.6x as long as wide; MV shorter, as long as PMV; gastral petiole shorter, length 2.3x width .... *indiana* sp. nov.

1. *Cryptoprymna elongata* sp. nov.

(Figs 1-6)

Female: Length 1.8-2.0 mm (Holotype 2.0 mm). Body black. Antennae testaceous with clava darker. Legs with coxae concolorous with thorax, remainder yellow, with tips of tarsi pale brown; tegulae pale brown; wings hyaline; veins pale brown.

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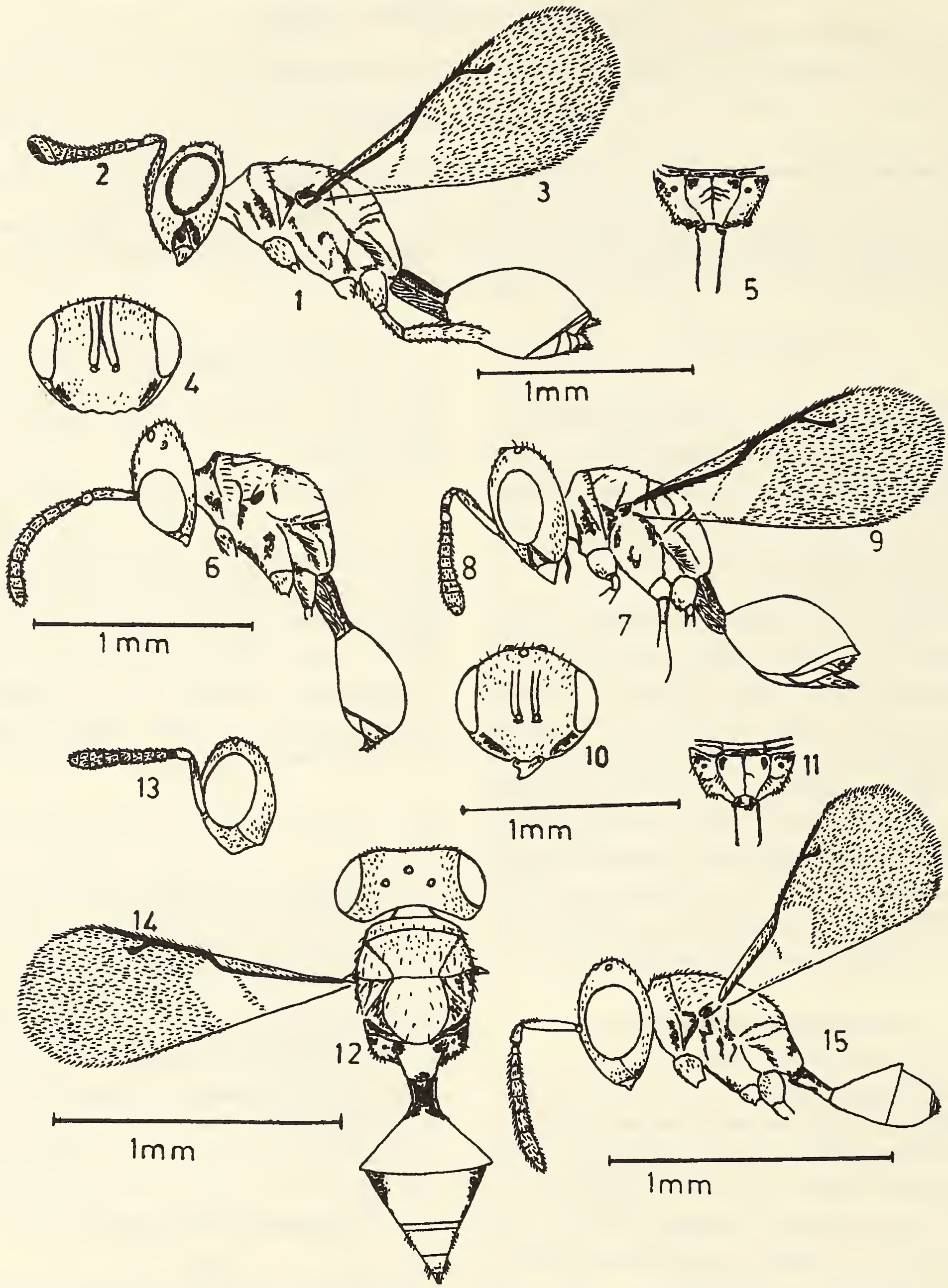

Figs 1-6: *Cryptoprymna elongata* sp. nov. (Female) 1. Body in profile; 2. Antenna; 3. Forewing; 4. Head in front view; 5. Propodeum in dorsal view; 6. Male body in profile.
7-11. *Cryptoprymna indiana* sp. nov. (Female) 7. Body in profile; 8. Antenna; 9. Forewing; 10. Head in front view; 11. Propodeum in dorsal view.
Figs 12-15: *Toxeumorpha minuta* sp. nov. (Female) 12. Body in dorsal view; 13. Head in profile with antenna; 14. Forewing; 15. Male body in profile.

Head: (Figs 1 & 4) uniformly and finely reticulate with scattered white hairs. In dorsal view width 2x length; temple moderately converging, length 0.5x eye length; POL 1.4x OOL. In front view, head width 1.3x height; anterior margin of clypeus slightly emarginate; malar space length 0.5x eye length; eyes separated by 1.5x their length. Antenna (Fig. 2) inserted just above lower margin of eyes; scape reaching median ocellus, length 1.3x eye length; pedicel plus flagellum as long as head width; clava a little longer than three preceding segments combined.

Thorax: (Fig. 1) pronotal collar margined anteriorly; anterior half finely reticulate and posterior half shiny. Mesoscutum finely reticulate, width 1.5x length. Scutellum similarly sculptured as on mesoscutum, length 1.2x width, frenal area shiny. Propodeum (Fig. 5) width 2x length, lateral parts finely reticulate. Forewing (Fig. 3) with basal vein setate. Relative lengths of SMV, MV, PMV, and STV as 24.5:15:12.5:8.

Gaster: (Fig. 1) length 1.5x width; petiole dorsally reticulate, laterally with longitudinal rugae, length 2.9x width.

Male: (Fig. 6) Length 1.7 mm. Generally resembles female but differing in having slender antennae with elongate funicular segments and clava not wider than funicle and in the nature of gaster.

Holotype: Female: INDIA. Kerala: Idukki (Kulamavu), 1.xii.1988, Coll. P.M. Sureshan.

Allotype: Male: Kerala: Palghat (Mukali), 10.xii.1987, Coll. P.M. Sureshan.

Paratypes: 1 Female, Kerala, Silent Valley, 30.xii.1988, 1 Female, Kerala, Wynaad (Manantody), 22.ii.1988 (Coll. P.M. Sureshan).

Biology: Not known.

Remarks: This species resembles *C. atra* Walker in having forewing with basal cell and vein setate, patch of setae ventrally behind MV; occiput concave in dorsal view, bare petiole, shorter propodeum, slender antennae and longer gaster. But it differs from *atra* in having a longer petiole (length 2.9x width), forewing with MV longer than PMV and 0.6x SMV. In *atra* the petiole is shorter (length 1.9x width), forewing with MV shorter than PMV and only about 0.4x SMV. It closely resembles *C. indiana* sp. nov., and the characters for separating it from *indiana* are given in the key to Indian species.

2. ***Cryptoprymna indiana*** sp. nov.
(Figs 7-11)

Female: Length 1.7-1.8 mm (Holotype 1.8 mm). body black; gaster brownish ventrally. Antennae testaceous, clava a little darker at tip. Coxae concolorous with thorax, legs otherwise testaceous with tips of tarsi brown. Tegulae light brown. Wings hyaline, veins pale brown.

Head: (Figs 7 & 10) uniformly and finely reticulate with several black bristles on vertex. In dorsal view, width 2x length; occiput concave; temple length 0.5x eye length; POL 1.4x OOL. In front view, head width 1.2x height; genae depressed considerably; malar space length 0.5x eye length; clypeus produced, anterior margin almost straight. Eyes separated by 1.5x their length. Antennae (Fig. 8) inserted slightly above lower margin of eyes; scape filiform, a little shorter than eye, not reaching front ocellus; pedicel plus flagellum length equal to head width; anelli transverse, equal in length; clava as long as 3.5 preceding segments combined.

Thorax: (Fig. 7) pronotal collar anteriorly margined, finely reticulate on anterior half and shiny on posterior half. Mesoscutum moderately reticulate, width 2.9x length. Scutellum with broad reticulation, frenal area shiny. Propodeum (Fig. 11) with median area moderately and closely reticulate, lateral parts finely reticulate, median and lateral carinae complete, spiracles small, oval, callus with a tuft of setae anteriorly. Prepectus, mesopleuron and metapleuron finely reticulate. Forewing (Fig. 9) with basal vein

setate; costal cell hairy on the upper half; speculum open below. Relative lengths of SMV, MV, PMV and STV as 22:11.5:11:6.5.

Gaster: (Fig. 7) length 1.5x width; petiole length 2.3x width, dorsally reticulate, laterally with very close longitudinal rugae.

Male: Not known

Holotype: Female: INDIA: Kerala: Peechi, 5.ii.1989, Coll. P.M. Sureshan.

Paratypes: 2 Females, Kerala: Silent Valley, 9.xii.1987; 2 Females, Kerala: Palghat (Anakkaty), 12.xii.1987; 1 Female, Kerala, Malampuzha, 11.xii.1987, Coll. P.M. Sureshan.

Biology: Not known.

Remarks: This species closely resembles *C. elongata* sp. nov. but can be distinguished from *elongata* by the characters given in the key. It also resembles *C. atra* in having setate basal vein, bare and shorter petiole, but differs in having a shorter antennal clava (1.6x as long as wide), shorter gaster and longer MV. In *atra* antennal clava more slender (2.1 ±0.21x as long as wide), gaster elongate and MV shorter.

Genus ***Toxeumorpha*** Girault

Toxeumorpha Girault 1915b: 195. Type species: *Toxeumorpha nigra* Girault, by original designation.

Nigricolana Boucek 1976: 16-17. Type species: *Trigonogastra nigricola* Ferriere, by original designation. Boucek 1988: 443. Synonymy.

Girault (1915b) erected the genus *Toxeumorpha* with type species *T. nigra* Girault from Australia. Boucek (1988) synonymised *Nigricolana* Boucek under *Toxeumorpha*. Before synonymising *Nigricolana* under *Toxeumorpha*, Boucek *et al.* (1979) transferred the species *Trigonogastra megacephala* Waterston 1915 to *Nigricolana*. Since *Nigricolana* was later synonymised under *Toxeumorpha*, the species *Nigricolana megacephala* (Waterston) should now be known as *Toxeumorpha megacephala* (Waterston) comb. nov. Presently there are three described species under this genus: *T. nigra* Girault (1915b) from Australia, *T. nigricolana* (Ferriere, 1936) from Africa and *T. megacephala* (Waterston, 1915) from Ceylon. The genus has restricted distribution and had not been reported from India so far.

Toxeumorpha minuta sp. nov.
(Figs 12-15)

Female: (Figs 12-14) length 1.2 mm. Body black; eyes brownish-black. Antennae brown with scape paler. Legs with hind coxae concolorous with thorax; fore and mid coxae blackish brown, remainder of legs testaceous, except fore femur and tips of tarsi brown. Tegulae brown; wings hyaline, veins pale brown.

Head: (Figs. 12 & 13) uniformly moderate reticulate. In dorsal view, width 1.8x length; temples round, converging, length 0.4x eye length; POL 1.4x OOL; occiput convex. In front view, head width 1.2x height; clypeus with a median angulate tooth; eyes separated by 1.3x their length. Antennae (Fig. 13) inserted along with lower margin of eyes; scape not reaching median ocellus, a little shorter than eye; combined length of pedicel plus flagellum 0.8x head width; pedicel longer than F1; third anellus as long as first and second combined; funicle segments quadrate; pubescence moderate and sparse on flagellum; clava a little shorter than three preceding segments combined.

Thorax: (Fig. 12) length 1.5x width, uniformly and moderately reticulate with black bristles dorsally except on propodeum; pronotal collar not margined, narrower than mesoscutum. Mesoscutum width 2.4x length; notaular grooves complete. Scutellum convex, without frenum. Propodeum width 2.6x length; nucha moderate; median area similarly sculptured as on scutellum, lateral parts finely reticulate; plicae complete; callus with similar black bristles as on other areas

of thorax; spiracles very small. Prepectus broad, triangular, finely reticulate. Mesopleuron and metapleuron moderately reticulate. Forewing (Fig. 14) length 2.3x width; marginal fringe moderately long; discal pubescence small and sparse; basal vein setate; speculum open below. Relative lengths of SMV, MV, PMV, and STV as 15:8:6:3.5.

Gaster: (Fig. 12) length 1.4x width; petiole finely reticulate with a median ridge, embraced by the extension of first sternite; T1 and T2 larger covering most of the gaster; hypopygium reaching beyond middle of the gaster.

Male: (Fig. 15) length 1.1 mm. Resembles female, but differs in having antenna with scape almost reaching median ocellus, flagellum covered with long hairs, F1 anelliform and gaster shorter with a longer petiole.

Holotype: Female: INDIA: Kerala, Calicut University Campus, (-).v.1989, Coll. P.M. Sureshan.

Allotype: Male, same data as that of holotype.

Remarks: This species resembles *T. megacephala* (Waterston) in general characters, but differs in having antenna with 3 anelli and 5 funicular segments in female, F1 as long as F2, forewing length 2.3x width with PMV more than half that of MV and distinctly longer than STV. In *megacephala* female antenna with 2 anelli and 6 funicular segments, F1 shorter than F2, forewing length less than 2x width with PMV half as long as MV and only slightly longer than STV. The male of this species also resembles *T. megacephala* male but differs in having antenna with F1 very short, anelliform, pedicel distinctly longer than wide (*megacephala* male possesses an antenna with F1 not anelliform and pedicel hardly longer than wide).

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GARRA ELONGATA, A NEW SPECIES OF THE SUBFAMILY GARRINAE FROM MANIPUR, INDIA (CYPRINIDAE, CYPRINIFORMES)[1]

WAIKHOM VISHWANATH AND LAISHRAM KOSYGIN[2]

(*With one plate and one text-figure*)

Key words: *Garra elongata*, new species, Manipur, *gotyla* complex

Garra elongata sp. nov. is described from a hill stream of the Chindwin basin in Manipur, India. It is characterised by 39-40 lateral line scales, 13 predorsal scales, 2½ scale rows between lateral line and pelvic fin origin, a transverse groove on snout tip, a weakly developed proboscis, and position of vent situated midway between pelvic and anal fin origins. Further, it is characterised by a transverse black bar on the dorsal fin and a longitudinal black streak on median rays of caudal fin. *G. elongata* is considered as a member of *gotyla* complex.

INTRODUCTION

Menon (1964) reviewed the genus *Garra* Hamilton 1822, and recognised 37 species. It is chiefly characterised by a suctorial disc on the ventral surface of the head, just behind the mouth. Most species of this genus inhabit rapid running waters. They adapt to the swift current by clinging to the substratum with their suctorial disc and horizontally placed paired fins (Menon, 1964). They are widely distributed in Asia and Africa (Talwar and Jhingran, 1991).

In Manipur, fishes of the genus *Garra* are distributed both in the Brahmaputra and Chindwin basins. Hora (1921) described *G. naganensis* from Senapati stream, Brahmaputra basin, Manipur. Vishwanath and Sarojnalini (1988) described *G. manipurensis* from the Manipur river (Chindwin basin). Vishwanath (1993) reported the occurrence of nine species of *Garra* in Manipur, namely, *G. gotyla gotyla* (Gray 1832), *G. nasuta* (McClelland 1838), *G. rupecula* (McClelland 1839), *G. lissorhynchus* (McClelland 1842), *G. gravelyi* (Annandale 1919), *G. kempi* Hora 1921, *G. naganensis* Hora 1921, *G. manipurensis* Vishwanath & Sarojnalini 1988, and *G. litanensis* sp. nov. During our studies on the fish diversity of Ukhrul district, Manipur (Chindwin basin), four undescribed specimens of *Garra* were collected in November, 1997. They are described herein as new species.

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MATERIAL AND METHODS

Measurements and counts followed Menon (1964). Measurements were made with a dial calliper to the nearest 0.1 mm and expressed in percentage of standard length (SL) or head length (HL). The type specimens of the new species are deposited in the Manipur University Museum of Fishes (MUMF).

Garra elongata sp. nov.

(Plate 1, Fig. 1)

Holotype: Regn no. MUMF 2311, 94.9 mm SL; Locality: INDIA: Manipur: Chindwin basin: hill stream near Tolloi, 25° 12' N, 94° 20' E, *c.* 2,016 m above msl; Coll. L. Kosygin, 12.xi.1997.

Paratypes: Regn no. MUMF 2308-2310, 3 ex., 77.9-85.5 mm SL; collection data same as holotype.

Material examined: *Garra gravelyi*: MUMF 64/7, 1 ex.; India: Manipur, Lokchao river; W. Viswanath, 21.vi.1984. – MUMF 2273, 1 ex.; India: Manipur, Wanze stream at Khamsom, 94° 32' E, 25° 12' N; L. Kosygin, 7.vii.1997. *G. gotyla gotyla*: MUMF 66/1-2, 2 ex.; India: Manipur, Lokchao river; 12.viii.1984.

Vishwanath, Waikhom *et al.*: *Garra elongata* sp. nov. PLATE 1

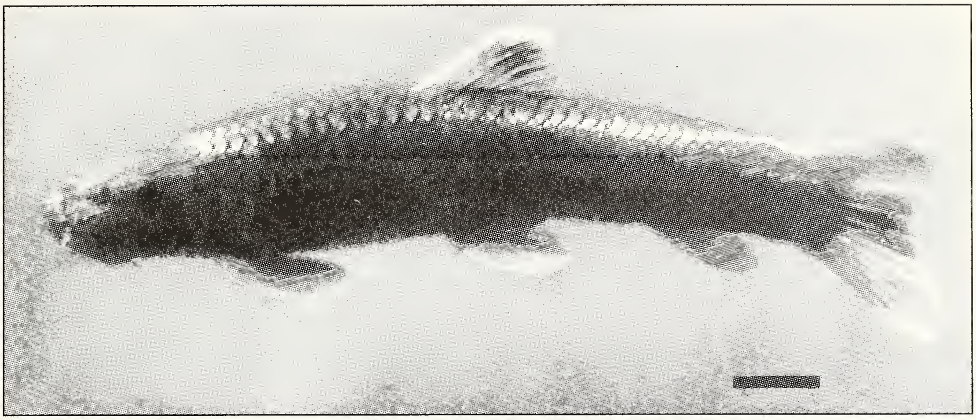

Fig. 1: Lateral view of *Garra elongata* sp. nov. (MUMF 2311 - holotype, 94.9 mm SL). Scale bar = 10 mm.

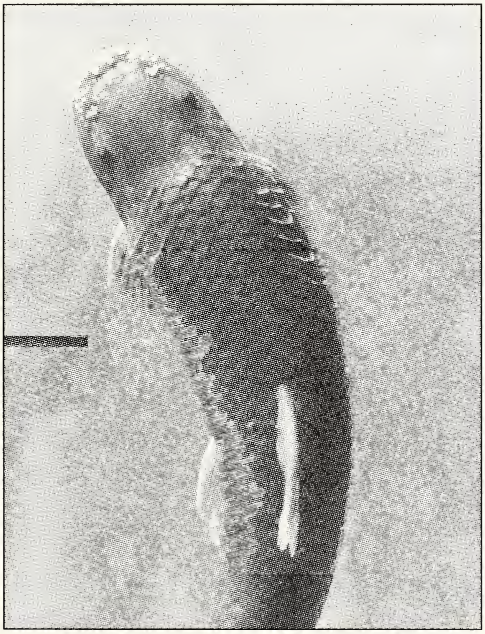

Fig. 2: Dorsal view of *G. elongata* (holotype). Scale bar = 10 mm.

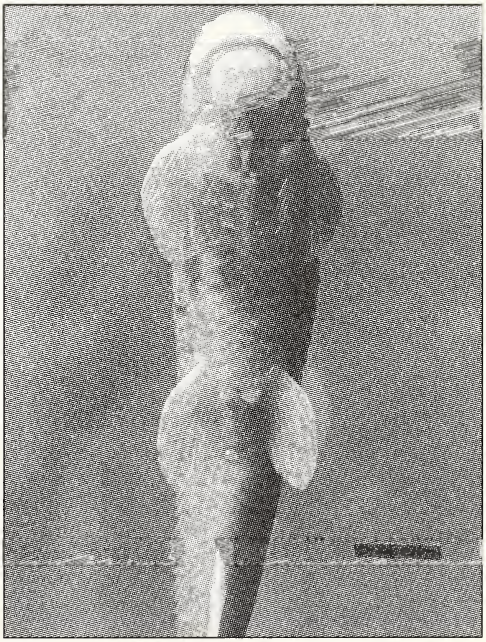

Fig. 3: Ventral view of *G. elongata* (MUMF 2308 paratype, 80.0 mm SL). Scale bar = 10 mm.

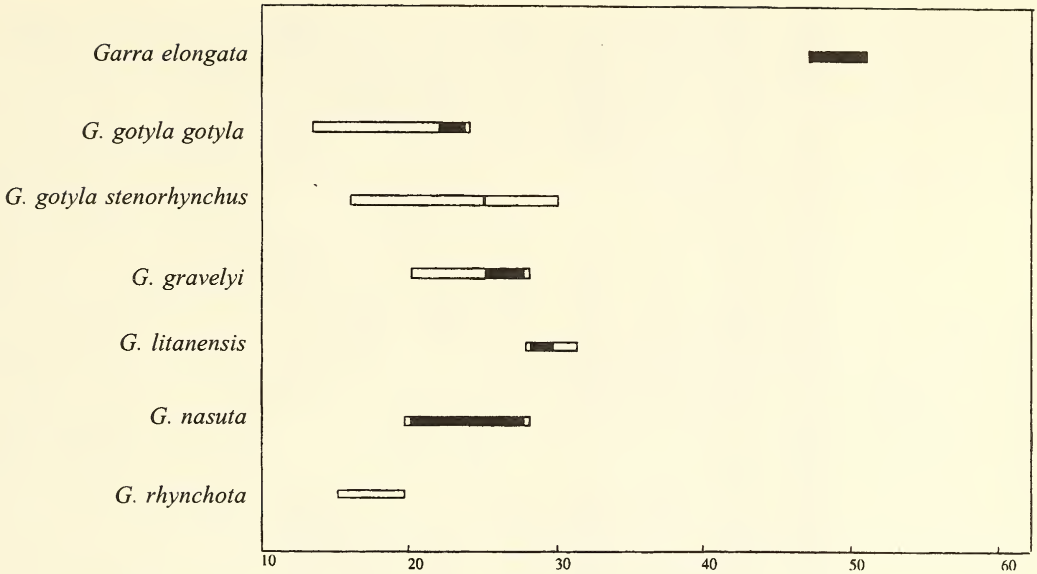

Fig. 4: Comparison of percentage distance between vent and anal fin origins, in the distance between pelvic and anal fin origins of the *Garra gotyla* species complex.

Garra gotyla stenorhynchus: ZSI (Zoological Survey of India, Calcutta) F 1748, 1ex.; India: Moyar river at Nilgiris; 15.iv.1955. *G. kempi*: MUMF 2251-2254, 4 ex.; India: Manipur, Wanze stream at Khamsom; L. Kosygin, 30.iv.1995. *G. litanensis*: MUMF 68/1, 1 ex., type; India: Manipur, Litan stream at Litan; W. Viswanath, 16.iii.1986. MUMF 69/1-3, 3 ex.; paratypes; India: Manipur, Litan stream at Litan; W. Viswanath, 12.ii.1988. *G. nasuta*: MUMF 2098, 1 ex.; India: Manipur, Chalou river at Jessami 94° 35' E, 25° 38' N, L. Kosygin 2.vi.1994, MUMF 2270-2272 3 ex. India, Manipur, Wanze stream at Khamsom; L. Kosygin, 7.vii.1997.

Diagnosis

A species of *Garra*, distinguished from its congeners by the following combination of characters: 39-40 lateral line scales, 13 predorsal scales, 2½ scale rows between lateral line and pelvic fin origin, transverse groove on snout, weakly developed proboscis, no scales on chest, 7 branched dorsal fin rays, 11-12 branched pectoral fin rays and position of vent situated midway between pelvic and anal fin origins. It is also distinct in having a dorsal fin with a transverse black bar, and caudal fin with a longitudinal black band in the middle (Table 1).

Description

General body shape and appearance are shown in Plate 1 Fig. 1. Dorsal fin rays I, 7 (last ray branched at base); pectoral fin rays I, 11-12; pelvic fin rays I, 8; anal fin rays I, 5; caudal fin rays 10+9 (17 branched); lateral line scales 39-40; lateral transverse scales 3½ between dorsal fin origin and lateral line and 2½ between lateral line and pelvic fin origin, predorsal scales 13.

The measurements in mean and ranges (in parentheses) are given here. Body elongate and subcylindrical, depth 18.5 (17.4-19.2)% of SL.

TABLE 1
COMPARISON OF MORPHOLOGICAL CHARACTERS OF *GARRA ELONGATA* SP. NOV., *G. GOTYLA GOTYLA*, *G. GRAVELYI*, *G. NASUTA* AND *G. KEMPI*

	G. elongata	*G. gotyla gotyla* (after Menon, 1964)	*G. gravelyi* (after Vishwanath, 1993)	*G. nasuta* (after Vishwanath, 1993)	*G. kempi* (after Menon, 1964)
In % of SL					
Body depth	18.5 (17.4-19.2)	23.9 (20.0-27.0)	23.7 (21.1-25.8)	22.9 (17.5-25.7)	16.7 (14.3-18.6)
In % of HL					
Snout length	47.6 (45.4-50.0)	54.6 (47.6-62.1)	51.8 (46.1-56.1)	57.5 (51.8-60.9)	52.6 (46.9-59.5)
Disc length	42.9 (42.0-44.1)	40.8 (34.8-45.0)	34.8 (28.2-39.5)	40.5 (36.0-48.3)	47.2 (38.7-56.2)
In % of distance from ventral to anal					
Distance from vent to anal fin origin	48.8 (47.5-51.2)	19.4 (13.9-24.4)	24.5 (20.8-28.6)	22.6 (19.0-26.9)	49.7 (45.4-54.6)
Counts					
Dorsal fin rays	2/7	3/7-8	-	-	2/8
Predorsal scales	13	9-10	8-9	9-10	12-14
Lateral line scales	39-40	32-35	32-34	33-34	38-40
Lateral transverse scales	3.5/2.5	4.5/3.5	-	-	3.5-4.5/3.5
Scales on chest	absent	present	present	present	absent
Probosis	Weakly developed	Single lobed	Weakly developed	Trilobed	Absent
Colour of fins	Dorsal fin with transverse black bar and caudal fin with longitudinal black band	Dorsal and caudal fin without dark bands	Dorsal and caudal fins without dark bands	Dorsal and caudal fins without dark bands	Dorsal and caudal fins without dark bands

Head moderately compressed, flattened ventrally, length 21.8 (21.1-22.4)%, height at occiput 14.1 (13.1-14.8)%, head width 17.4 (16.4-18.4)% of SL. Mouth inferior, transverse with thick and fleshy lips. Upper lip fimbriated. Suctorial disc well developed, its length 69.2 (65.6-73.8)% of its width. Gill opening restricted to sides. Snout rounded with a deep transverse groove at the tip. Proboscis weakly developed. Tip of snout in front of nostril studded with many horny tubercles. Snout length 10.4 (9.8-10.8)% of SL, 47.6 (45.4-50.0)% of HL. Interorbital space slightly convex 10.5 (10.3-10.6)% of SL. Eye diameter 3.6 (3.3-4.0)% of SL, not visible from ventral surface. Height of caudal peduncle 12.1 (11.7-12.8)% of SL, caudal peduncle length 19.0 (17.8-20.8)% of SL. Barbels two pairs, one rostral and one maxillary, both more or less equal to eye diameter. Scales of moderate size, absent on chest, poorly developed on belly.

Dorsal fin base length 47.1 (46.7-47.7)%, height 18.8 (18.0-19.2)% of SL. Predorsal length 47.1 (46.7-47.7)% of SL. Pectoral fin almost equals dorsal fin height, its length 18.3 (18.0-19.2)% of SL, 84.3 (81.4-86.0)% of HL. Pelvic fin shorter than pectoral fin, not reaching vent, its length 16.6 (16.0-17.1)% of SL. Caudal fin forked, its length 19.9 (19.0-20.5)% of SL. Vent in middle of pelvic and anal fin origins, distance from vent to anal fin origin 48.8 (47.5-51.2)% of the distance from pelvic to anal fin origins.

Coloration: Dark greenish-grey; dorsally black; ventral surface pale white. A broad, dark grey longitudinal stripe from gill opening to caudal fin base. Scales on lateral sides of body orange. Dorsal fin with a broad, transverse black bar near the free margin. Caudal fin with a black, longitudinal mark on median rays (black colour appears on 8th-12th branched rays). All the fins orange.

Preserved specimens: Body dark grey, darker on the back. Black area on dorsal and caudal fins as in live specimens.

Etymology: Named after its greater standard length in relation to the body depth compared to other representatives of the *gotyla* complex.

Distribution: INDIA: Manipur, Ukhrul district, Tolloi (Chindwin basin)

Discussion

Garra elongata has a close phylogenetic relationship with species of the *gotyla* complex in having tubercles and a proboscis on snout. However, it is easily distinguished from *G. gravelyi*, *G. gotyla gotyla*, *G. gotyla stenorhyncus*, *G. litanensis* and *G. nasuta* in having more lateral line scales (39-40 vs. 32-35), more predorsal scales (13 vs. 8-10), fewer scale rows between lateral line and pelvic fin origin (2.5 vs. 3.5), absence of scales on chest and more anteriorly placed vent. Further, the new species is distinct in having (i) a distinct transverse black bar on dorsal fin and (ii) absence of black spots at the base of its branched rays.

The new species is also similar to species of *yunnanensis* complex in respect of the number of lateral line scales, number of predorsal scales and more anteriorly placed vent. Further, it is nearer to *G. kempi* in having the vent in the middle of pelvic and anal fin origins. However, it is easily distinguished from *G. kempi* by a deep transverse groove on its snout, weakly developed tuberculated proboscis on the snout, distinct black bar on the dorsal fin, longitudinal black band on the median rays of caudal fin and fewer scale rows between lateral line and pelvic fin origin (2.5 vs 3.5).

Menon (1964) considered gradual shifting of vent forward and development of proboscis on snout as interesting adaptations of *Garra* to rapid running waters, which are of great taxonomic significance within the genus. Vishwanath (1993) pointed out that in

lissorhynchus and *yunnanensis* complexes, which do not possess a proboscis, the vent has shifted far forward of the anal fin, whereas in the *gotyla* complex, where a proboscis is present, the vent is not far forward. Thus, the new species appears to be more adapted to rapid running waters than any other member of the species complexes in the genus.

Acknowledgement

We are grateful to the University Grants Commission Special Assistance Programme for financial assistance.

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REVIEWS

1. PRIMATES OF NORTHEAST INDIA by Arun Srivastava. Megadiversity Press, Bikaner 1999. Pp. 208, (21.5 x 14 cm). Paperback price Rs. 250/-.

Mountainous terrain, dense jungle, incongenial climate coupled with political instability and wide lingual diversity, are the salient features of the northeast region of India. Notwithstanding these daunting facts, the author has spent considerable time and effort in conducting extensive field studies to provide us with detailed information on the primate species observed in this region. The author has also sought to illustrate the socio-political scenario of the region, thus providing an invaluable source of information to the discerning reader.

The book begins with a chapter on the history of northeast India. The reader is informed about the political state of this region, through ancient history, till the formation of seven northeastern states of India. Various aspects like lingual and racial diversity have been explored. The description of the annexation of this region by the British is too detailed and complicated. Since the reader of this book will be interested in primates, extensive details of history seem irrelevant and unrelated to primates.

The reader is then introduced to the people and ethnographic affinities of the 7 states of this region. Here, the author goes through a brief description of each state mentioning its latitudes and longitudes, climatic conditions, and also the ethnic diversity of the population. Thus, we get a clear picture of the human neighbours and the environmental conditions faced by the primates.

It is from the third chapter that the author shows his mettle as a researcher. Forest types are discussed, accompanied by detailed lists of the floristic composition of the region. The lists mention scientific names.

The succeeding chapters introduce primates in general and deal with the various aspects of primate life like habitat, food and a complete profile of each of the northeast Indian primate species. Each of these chapters is filled with interesting and informative data. The author discusses primate diet and food selection in relation to the surrounding flora. The description of each tree is accompanied by a diagram which helps in its field identification. A very thoughtful and appreciated gesture.

The species-wise profile of each primate has been made very meticulously. The use of maps showing the range and habitat of each primate is very helpful. Throughout the book, the author uses lucid writing, which succeeds in making our education about primates of northeast India an interesting experience.

The author ends the book on a sombre note, mentioning the conservation problems faced by primate habitats and ranges. He also shows the alarming trend of most primates attaining the status of highly endangered species or data deficient species, bringing home the point that a lot needs to be done if we are to protect our northeast Indian primates. All in all, a must read for primate conservationists, researchers and even nature enthusiasts.

■ MEGHANA GAVAND

2. GREEN POLITICS Eds Anil Agarwal, Sunita Narain and Anju Sharma. Published by Centre for Science and Environment, New Delhi, 1999. Pp. 409, (26.5 x 21.5 cm). Price not given.

The innocent age of conservation when the boldest and perhaps the only step taken was to officially protect a species or a natural area, is over. Its place has been taken over by green

politics. Due to pressure of human and livestock populations on land, consumerism and globalization, peoples' rights, and rampant corruption, the conservation movement has to face numerous hurdles.

GREEN POLITICS, the first in the series of Global Environmental Negotiations, is a book which should be read by every conservationist, just to know the depth of complexities involved in conservation these days. The book contains nine chapters dealing with negotiations regarding climatic changes, biodiversity convention, persistent organic pollutants, timber trade, World Trade Organization and Global Environment Facility among others. It is full of data, tables, graphs and box items highlighting important events, regulations and issues. Cartoons, for which the publications of CSE are now famous, graphically convey the message of each chapter.

The editors have taken help from a number of institutions, experts, books, reports and research papers to compile each chapter. Names of institutions and individuals are given in the beginning, but they are missing in the chapter, making it difficult to know who helped in writing which chapter. Nevertheless, the book is a useful reference guide, although a bit heavy and arcane in places. I think this book should be present in all the libraries of universities and institutions, and it should be made compulsory reading for our decision makers, because today the major conservation battles are fought in the corridors of power in Delhi, Montreal, Kyoto, Washington etc. and not in some remote forested valleys and neglected grasslands. The days of green politics have arrived.

■ ASAD R. RAHMANI

3. THE FRESHWATER FISHES OF THE INDIAN REGION by K.C. Jayaram. Narendra Publishing House, Delhi, 1999. Pp. 551. 18 plates, (24 x 18 cm). Hardbound price Rs. 995/-.

There have been several stalwarts in the field of fish taxonomy who will be remembered with awe and affection. Outstanding among them are father figures of the 19th century like Hamilton-Buchanan, J. McClelland, W. Sykes, T.C. Jerdon, P. Bleeker and, of course, Francis Day, whose monumental work of 778 pages (Volume 1) and 195 plates (Volume 2) titled THE FISHES OF INDIA, BEING A NATURAL HISTORY OF THE FISHES KNOWN TO INHABIT THE SEAS AND FRESH WATERS OF INDIA, BURMA AND CEYLON, but affectionately abbreviated to FISHES OF INDIA encompassing 1,418 species, is still the mainstay of every Indian ichthyologist.

In the 20th century, S.L. Hora stood tallest among "fish people", being followed, after his death in 1955, by several others such as K.S. Misra, R. Tilak, A.G.K. Menon, K.C. Jayaram, P.K. Talwar and A. Jhingran. There are a few others, but what separates the abovenamed is that all of them, in addition to their scientific papers, have also authored books on fish systematics and thus, carved a niche for themselves.

Jayaram's earlier publication, THE FRESHWATER FISHES OF INDIA, PAKISTAN, BANGLADESH, BURMA AND SRI LANKA — A HANDBOOK came out in 1981. He has now followed it up with THE FRESHWATER FISHES OF THE INDIAN REGION (1999). Of course, he has justified this repetition within 18 years by explaining that this was necessitated in order to update and incorporate changes in classification and nomenclature. I was curious to find out if it is just a re-hash of his earlier work or an elaborate revision. When we compare his current publication with the earlier one, we find an increase from 475 pages (of his HANDBOOK) to 551 pages, and from 13 plates (plus a frontispiece) to 18. The species covered have increased from 742 to 852, and the genera from 233 to 272.

His illustrations are of a high quality, and

the addition of Fig. 8 will help the novice. I could detect a few, albeit minor mistakes which are likely to confuse a beginner. In Fig. 2A (for lateral transverse scale count), the hatched scales are from the lateral line to the posterior margin of the pelvic fin. They should start from the (anterior) base of this fin. They were shown correctly in his HANDBOOK (page 8, Fig. 2A).

In Fig. 2B (length of base of adipose dorsal fin), the line is drawn from the rounded tip of this fin. It should be drawn from the posterior base of the fin.

In Fig. 3B, V.F. is given as pelvic fin. For the benefit of beginners, it should have been explained that pelvic fin is also sometimes called ventral fin. (Even in the glossary, these fins are not mentioned.).

The statement on page 5, "Dividers should have one point flat at right angles to the place of operation and the other kept at a needle point." is not clear.

In Fig. 4B, while the description in the text mentions "length" (of pectoral fin spine), the figure legend mentions "height" (This was given correctly in Fig. 5C of the HANDBOOK).

On page 8, suborbital width is defined as the least distance from the lowermost margin of the orbit to suborbital or postorbital margin. In the absence of an illustration or a definition of sub- or pre-orbital margin, this is likely to confuse the novice.

Again on page 8, interorbital shield is not explained, even in the glossary.

In Fig. 9D, the gill rakers should have been marked, to distinguish them from gill filaments (for beginners).

It is a great relief to find that the new book has been well edited, and that there are hardly any mistakes; while reviewing Jayaram's HANDBOOK, I had detected well over 105 mistakes. His scientific treatise is, as usual, meticulous, as he has covered all the taxonomic changes up to 1998.

Unfortunately, though India has over 1,570 known marine fish species and only 930 inhabiting fresh waters, all the recent books on fish systematics have been restricted to fresh-water fishes. It is hoped that someone will now come forward and bring out similar ones for marine fishes. From 1878 (Day's *magnum opus*) to the 21st century is a long time to wait for such a work.

■ B.F. CHHAPGAR

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MISCELLANEOUS NOTES

1. MALAYAN TREE SHREWS *TUPAIA GLIS* (DIARD) IN SIKKIM

During a visit to Sikkim, to appraise the assessment of a river valley project from mid-March to mid-April, 1999, I had the opportunity of sighting tree shrews in the Teesta valley. The almost completely uniform brown colour and fluffy tail confirmed that they were Malayan tree shrews (*Tupaia glis*). Prater (THE BOOK OF INDIAN ANIMALS, 1993) defines the distribution range of the species from Myanmar (Burma), through Assam into the eastern Himalayas where it is known to inhabit a wide range of altitudes about 350 to 1,830 m and comments that they are easily distinguished from Indian tree shrews (*Anathana ellioti*) by the lack of nearly white ventral surface which is present in the latter. Subsequently, I had an opportunity to visit Gangtok (1,850 m above msl) during the period mentioned above, where I saw a few more individuals of the Malayan tree shrew.

Three races of Malayan tree shrews have been described in India namely *assamensis*, *versural* and *lepcha* (Prater 1993). However, identification of the race, of the individuals sighted, was not possible during this visit. A senior forest official, Mrs. Usha Ganguli-Lachungpa of the Sikkim Forest Department, confirmed that tree shrews are commonly found in the state, but no research has been done on the species so far.

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February 2, 2000

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2. RANGE OVERLAP IN DHOLE *CUON ALPINUS* PALLAS AND WOLF *CANIS LUPUS* LINN. (FAMILY: CANIDAE), IN INDIA

We present here our observations on range overlap of dhole (*Cuon alpinus*) and wolf (*Canis lupus*) in certain parts of India and discuss the possible reasons for the observed pattern.

In India, dhole is found commonly in the forests of the Western Ghats, and parts of the fragmented forests of the Eastern Ghats in the southern states, most forested areas of central Indian highlands and the moist forests of Orissa and Bihar states (Johnsingh 1985). Dholes are also reported from other places, but are not as commonly found. Johnsingh (1985) observes that their preferred habitat is dense forest, interspersed with open land, as well as sparsely wooded forest with adequate prey and water.

Wolves are distributed commonly in the northwestern arid areas, central Indian highlands and in the Deccan plateau of India. The population is almost continuous within the states of Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh (Jhala 1993). Scrubland and grassland of the semi-arid parts of peninsular India are the preferred habitats. However, as an exception, an eastern wolf population occurs in the moist forests of Orissa and Bihar (Jhala 1993). Jhala (1993) also observes that the wolves usually do not occur in closed forests, but sometimes do occur on the periphery of such forested areas. In the Indian trans-Himalayan areas, different subspecies of both dhole and wolf are sympatric (Fox and Chundawat 1992).

From these accounts, it is evident that the geographical ranges of dhole and wolf do overlap,

in India, to a considerable extent, interestingly mostly in the central Indian highlands. Yet, their preferred habitats do seem to vary. The wolves are adapted to arid open environs and dholes to closed forests. Interspecific competition between them appears to be the most plausible reason for this segregation. However, at places where their preferred habitats meet, or at places where there is a mosaic of habitats providing niches for both these species, they are found to occur together. Interestingly, in central India, most forests exist as a mosaic of habitats, due to the historical disturbances caused by the human population, and thereby offer resources to both the species.

Some examples of such places where the two species occur together are: Panna (Madhya Pradesh) and Palamau (Bihar) Tiger Reserves, parts of Bihar and Orissa forests. Even in these areas, the wolves may be occupying the periphery of the forests or around human settlements inside forests, whereas dholes occur in the less inhabited areas, as in Panna (Yoganand 1998). Temporal segregation between them may also be seen, as in Panna, where the wolves occur more often in winter. The dholes are largely diurnal, whereas wolves are mostly nocturnal. The dholes thrive on wild prey, while wolves are dependent on domestic livestock in most of their range. In places where the two species occur together, either or both may occur at low densities, as in Panna. Quantification of the exact parameters that enable these two coursing predators to occur together would enhance our knowledge and help conserve these two endangered species.

August 16, 1999

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3. THE SPECIES OF THE WILDCAT IN INDIA : A COMMENT ON 'THE DESERT CAT IN PANNA NATIONAL PARK' *JBNHS*, Vol. 96(1)

With reference to the abovementioned note in the *JBNHS*, 96(1), K. Yoganand is in error in citing Corbett and Hall (1992) as describing the Indian subspecies of *Felis silvestris* as *F. lybica* or *F. s. lybica.* The authors identify the Indian form of *F. silvestris* as subspecies *ornata.* Some authorities do consider Asiatic and African wildcats to be conspecific as *F. lybica* spp., but the now commonly used taxonomy by C. Wozencraft in MAMMAL SPECIES OF THE WORLD (1993) describes *lybica* and *ornata* as synonyms, i.e. subspecies, of *F. silvestris,* which agrees with Corbett and Hall (1992).

Common names are a matter of usage and are not authoritative. Nowell and Jackson (1996), considered it more appropriate to call *F. s. ornata* the Asiatic wildcat rather than the Indian desert cat. India is on the southeastern fringe of the

range, which extends westward to the southern and eastern shores of the Caspian Sea, and through the Central Asian Republics to Xinjiang and southern Mongolia.

August 12, 1999

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4. KANHA NATIONAL PARK BECOMES A NEW NIDUS FOR ELEPHANT SCHISTOSOMIASIS

(*With one text-figure*)

Schistosomiasis in elephants is a little known infection, due to little attention paid, or to low prevalence of the infection. Vogel and Minning (1940) described the first schistosome *Bivitellobilharzia loxodontae* from an African elephant (*Loxodonta africana*). Mudaliar and Ramanujachari (1945), described another species *Schistosoma nairi* (amended to *Bivitellobilharzia nairi* by Dutt and Srivastava, 1955), from an Asian elephant (*Elephas maximus*) from Coimbatore district, Tamil Nadu, which was redescribed by Sundaram *et al.* (1972). Rao and Hiregaudar (1953), reported the occurrence of *B. nairi* from six elephants of North Kanara division of the erstwhile Bombay state, whereas Kalapesi and Purohit (1957) described its histopathology. More recently, Islam (1994) mentioned its presence in the elephants in Kaziranga National Park, Assam. So far, *B. nairi* has been reported from the natural habitats (Kerala, Tamil Nadu and Assam) of the elephant. We are now reporting its presence in Kanha National Park, Madhya Pradesh, where only domesticated elephants remain.

Kanha National Park (22° 07'-22° 27' N and 80° 26' - 80° 03' E) in Mandla district, Madhya Pradesh (M.P.), India, harbours 27 Asian elephants which are being used for wildlife tourism. Of these, one tusker was brought some 25 years ago from Coimbatore. Of the rest, 7 were brought from Sonepur (Bihar, 18 years ago), 3 were caught from Sarguja (M.P., 10 years ago), while the rest were born and reared in the Park. The elephants frequent ponds and other water sources for bathing, and in summer they spray water on their body. This behaviour is favourable for picking up blood fluke infection.

Of the 27 elephants, faecal samples from 25 were examined by acid-ether method. The whole sediment, divided into three parts, was examined with and without a coverslip under 50x magnification. Camera Lucida drawings were made (400x) to study the morphology and measurements of the eggs (Fig. 1). Out of 27 elephants, 8 (32%) were found positive for eggs of *B. nairi* whose size varied from 122 x 77 to 205 x 90 µm, with a spine size ranging from 6.2 x 2.35 to 8.3 x 3.2 µm. The egg was oval, with a stout, abrupt spine present on one extremity (Fig. 1). The shape varied with their orientation, but was similar to that described by previous workers (Mudaliar and Ramanujachari 1945, Rao and Hiregaudar 1953, Sundaram *et al.* 1972). Moreover, the shape was distinctly different from those of *Orientobilharzia dattai*, *Schistosoma incognitum, S. nasale, S. spindale* and *S. indicum* — the blood flukes reported from Jabalpur area (Agrawal *et al.* 1991). However, there is a variation in the size of the eggs reported by us, and sizes reported by Mudaliar and

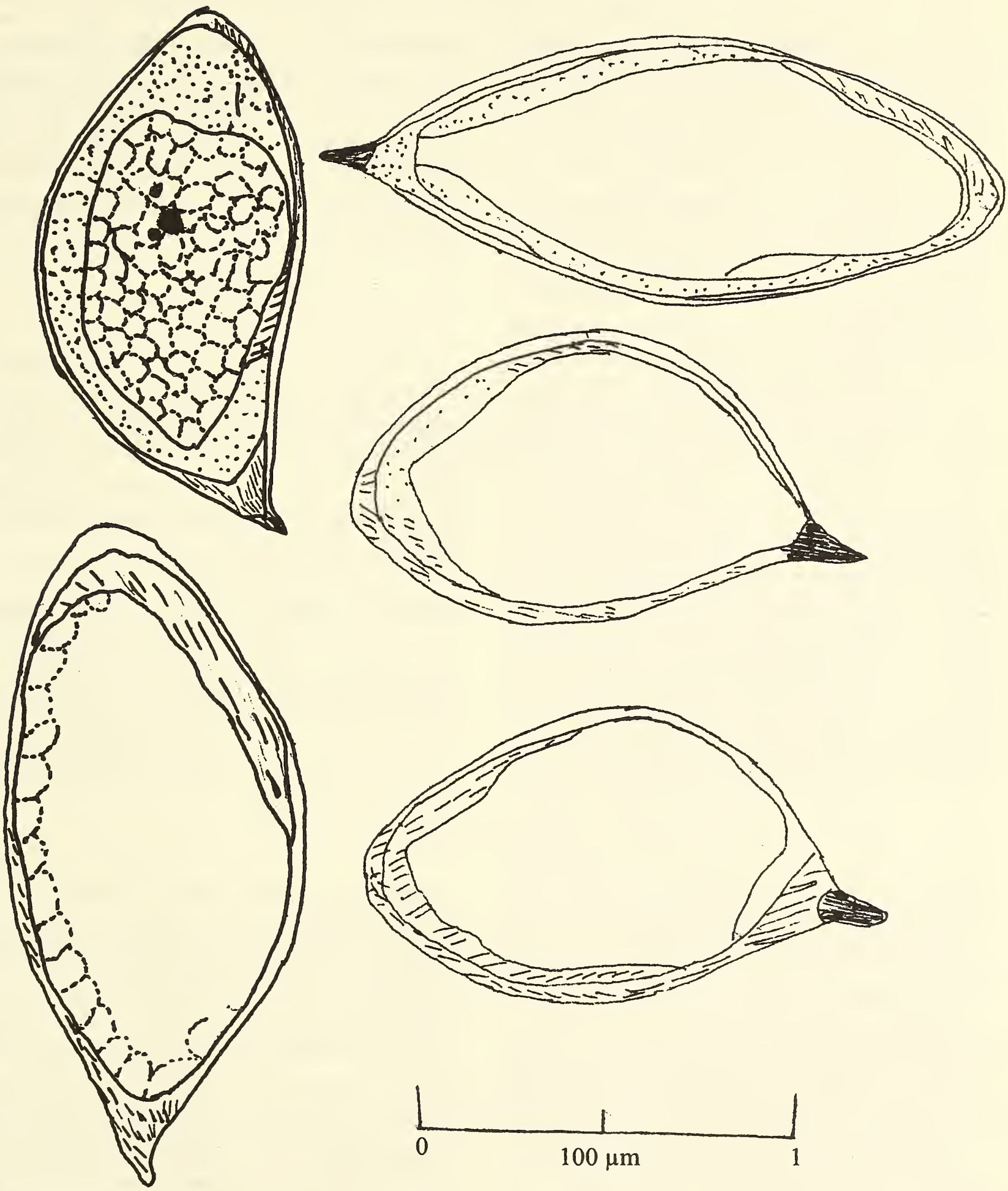

Fig. 1: Camera Lucida drawings of *Bivitellobilharzia nairi* eggs from elephants

Ramanujachari (1945), and Sundaram *et al.* (1972).

Of the eight infected elephants, 4 are juveniles, 3-5 years of age, which were born and reared in Kanha, confirming that these elephants have picked up *B. nairi* infection in the Park itself. Thus, Kanha now has a nidus of *B. nairi.* This is probably due to two factors. In the first event, the nidus was existent in Kanha, where the other animals maintained the infection, but it remained undetected. The elephants picked up the infection from Kanha and are identified as positive. However, so far, *B. nairi* has been reported exclusively from elephants throughout the country (though bloodflukes have a wide host range at the sexual stage). Thus, the parasite might be restricted to elephants. In this case, the elephant from Coimbatore may have introduced *B. nairi* and spread it in Kanha. The miracidia emerging from eggs of *B. nairi* successfully infected freshwater snails of Kanha National Park, thus making it a new nidus of the parasite. This reflects the capability of *B. nairi* to establish itself in a new geographical area. On a visit to Kanha, the second author (MCA) noted the freshwater snails *Indoplanorbis exustus, Lymnaea luteola, L. auricularia, Melanoides* and *Vivipara*. So far, only *I. exustus* and *L. luteola* have been confirmed as the intermediate hosts for Indian schistosomes. In all likelihood, *B. nairi* is also utilizing at least one of these two snails. According to Chauhan *et al.* (1972), cercariae of *B. nairi* have an eye spot (ocellate), hence one must be careful while searching for the intermediate host of *B. nairi,* as ocellated cercariae are generally attributed to avian schistosomes.

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5. SIGHT RECORD OF METAD *MILLARDIA MELTADA* GRAY (FAMILY: MURINAE) AROUND RATNAGIRI, WESTERN GHAT REGION

During my ten year stay in Kolhapur, Ratnagiri (Maharashtra), I toured the surrounding areas extensively, where a variety of mammals, birds and reptiles were observed.

On night trips, a number of metads *Millardia meltada* were seen in all types of terrain. Strangely enough, their movements were mostly recorded from north to south. On a stretch of 100 km, as many as 70 metads were seen at a time, all moving in the same direction. In order to satisfy my curiosity, I back tracked occasionally and noticed the same behaviour. To my mind, this movement could be on account of foraging during the night for food.

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6. LESSER FRIGATE BIRD *FREGATA MINOR ALDABRENSIS* MATHEWS A RARE RECORD FROM SÁLIM ALI BIRD SANCTUARY, THATTAKAD, KERALA

Lesser frigate birds are recorded as accidental stragglers in the Indian subcontinent. There is only one specimen of the bird in the BNHS collection, a male which was storm-blown and entangled in a fishing net during the SW monsoon near Quilon in Kerala (S.H. Prater, *JBNHS 33*: 445). Apart from this, there are three sight records from Bombay during the SW monsoon (Taylor, *JBNHS 51*: 939). There are two specimens in the Colombo museum which were wrongly identified as *F. andrewsi*, but have since been corrected.

On July 1, 1998, a very weak frigate bird was seen on the lake edge of Sálim Ali Bird Sanctuary at Thattakad. There had been a strong wind with a speed of 75 kmph and heavy rain during the previous night. The Sálim Ali Bird Sanctuary is situated on the bank of Periyar river, and has a large waterbody constituted by the Periyar Valley Irrigation Project dam. The Sanctuary is mainly for tropical forest bird species. There are about 27 species of water birds recorded from the sanctuary, apart from the 300 species of forest birds. The sanctuary is about 75 km by road from the Arabian Sea coast (Cochin).

The specimen was taken to the Sálim Ali Wild Wings Trust research station at the Sanctuary headquarters. The bird was slightly bigger than a kite and also longer. It was brownish-black above with a white head, neck and belly. A prominent greyish-brown band was present on the breast. Hind neck feathers were white, becoming greyish-mottled towards the lower neck, tail deeply forked and black in colour. Tarsus short, fully feathered and webbed. Bill long, broader at the base, downcurved and hooked at the tip. The colour of the bill was greyish-blue, paler at the down curve and black at the tip. Nostrils unnoticeable, elongated slit almost at the base of the bill. Feet fleshy, grey with darker claws. Inner side of tarsus feathers were whitish, whereas the outer were dark brownish-black. Iris dark brown with a bluish-grey patch around the eyes. There was no moult except for the 1st tail feather on the left. All other tail feathers were old and worn out.

The identification of the bird was confirmed as *Fregata minor* for the following reasons: Black and white oceanic bird with long, pointed, streamlined wings, deeply forked tail, long bill, hooked at the tip, obsolete nostrils, short

and fully feathered tarsus with webs on the feet. Regarding the lesser frigate bird, 'female is the only frigate bird with white underparts and whitish throat', according to Alexander 1995; HANDBOOK Vol. 1, pp. 48. The bird is also suspected to be immature as the head and hind neck are white.

The first bird was recorded from Quilon in 1928 and this the second one from the Sálim Ali Bird Sanctuary, in 1998. This is the only female and immature specimen available in the Subcontinent now as per published records. The bird died after a day. When it was cut open its stomach was empty, and the ovary granular and ill developed. The stuffed specimen is displayed at the interpretation centre of the Sálim Ali Bird Sanctuary Museum.

Live measurements of the bird are as follows:

Wing	— 560 mm
Wing span	— 1,700 mm (57")
Bill (from feathers)	— 80 mm
Tarsus	— 25 mm
Middle toe	— 60 mm
Tail	— 125 mm (Inner) 228 mm (Outer)
Weight	— 680 gm

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7. PURPLE HERON *ARDEA PURPUREA* (LINN.) (ARDEIDAE) NESTING ON WATER HYACINTH *EICHHORNIA CRASSIPES* (PONTEDERIACEAE)

On April 29, 1997, we saw four nests of the purple heron *Ardea purpurea* on thick mats of water hyacinth *Eichhornia crassipes* on Kanajari village pond, 10 km northwest of Anand (22° 32' N, 73° 00' E) in Kheda district, Gujarat. The four nests were 10-15 m apart and far away from some *Acacia* trees emerging from the tank. The nest material contained water hyacinth and dry thorny twigs. Initially we thought that somewhat grown young ones were standing on the water hyacinth, but soon realized that they were nestlings in their nest, when we saw adult birds arriving, with greeting calls, and feeding the young. There were 2 young ones in two nests and one in the 3rd nest, all 5 weeks of age. The fourth nest was in the incubation stage. Considering the age of the young, and the known incubation period i.e. 26 days (Hancock and Kushian 1984), it can be presumed that the clutches were initiated in the first or second week of February. The heronry initiated on the *Acacia nilotica* trees standing within the pond had two nests of purple heron in the nest building stage, and one in the early incubation stage. On the same date, other colonial water birds in the heronry were little egrets (9), large egrets (10), little cormorants (12) and white ibises (8). Foraging cattle egrets (15) were seen in breeding plumage, but they had not initiated nest building.

The nest of the purple heron is usually made of *Phragmites* or *Typha* stems and built on a flattened site in dense reed beds, rushes or papyrus (Hancock and Kushlan 1984). Twig nests are also built in thickets in Asia (Ali and Ripley 1983, Hancock and Kushlan 1984). Hence, nesting on water hyacinth is a new record. Water hyacinth always floats on the water surface and hence the nest is safe against an increase in water level. The nests on *Phragmites* or Typha do not offer such safety. This observation indicates a prolonged breeding season (February to September or October) at a given site, with the probability of double nesting.

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8. PALLAS'S FISHING EAGLE *HALIAEETUS LEUCORYPHUS* (PALLAS) PIRATES FISH FROM AN OTTER *LUTRA LUTRA* (LINN.)

I observed four common otters (*Lutra lutra*) on boulders in the middle of the River Manas. The otters were fishing; they would come out of the water with the fish and feed while sitting on the boulder. A Pallas's fishing eagle was noticed circling above the otters, repeatedly trying to snatch the fish. It made two or three futile attempts by diving at the otter. After a while, the bird made another attempt. This time, the otter was frightened and dropped the fish, which was neatly picked up by the eagle in one swoop. The Pallas's fishing eagle is regularly known to pirate fish from other fish eating birds, or smaller eagles, but very few have been recorded robbing otters or other mammals (Prakash 1989).

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9. GROUP SIZE AND VIGILANCE IN INDIAN PEAFOWL *PAVO CRISTATUS* (LINN.), FAMILY: PHASIANIDAE

Flocking in birds is considered to be an adaptive social strategy against danger, and the evolution of gregariousness is an effective solution to the problem of the individual's vigilance load (Dimond and Lazarus 1974). Birds feeding in large flocks are safer (in terms of number of birds alert at any moment) and have more time to feed (in terms of the proportion of its time that an individual spends alert). It is known that the time budget of a species is related

to the flock size. A bird in a flock can allocate more time to foraging (Murton 1971, Rubenstein *et al.* 1977, Caraco 1979 and Saino 1994). However, Elgar (1989) reviewed over 50 studies of birds and mammals, and suggested that the observed negative correlation between time spent in vigilance and flock size in these studies could be confounded by other variables.

According to Giest (1977), the Indian peafowl *Pavo cristatus* is an opportunist that occupied the highly productive ecotone between forest and water, and thus evolved gregariousness and less aggressive behaviour. This paper investigates the relationship between flock size and vigilance behaviour of the Indian peafowl, accounting for the confounding variables of Elgar (1989).

A population of peafowl living in an agro-ecosystem on the outskirts of Aligarh town (27° 30' N, 79° 40' E) was studied. The potential predators in this area were the jungle cat *Felis chaus*, dogs *Canis familiaris*, and human beings. Observations were made on peafowl feeding on bajra (*Pennisetum typhoides*) stubble in November 1994, on eight consecutive days, between 0700 and 0930 hrs. Birds were observed from a fixed (elevated) point 120 m away from the stubble. Data on the following aspects were collected on focal animals: peck rate (number of pecks per minute) and vigilance behaviour (heads-up number per minute and duration in seconds of each head-up). The activity budgets of the focal individuals were also recorded at 15 second intervals. Activities were classified as feeding, pacing, resting, aggression and others. The proportion of time spent on each activity was calculated.

Peafowl groups were divided into three categories: solitary, group with 2-5 individuals and group with more than 5 individuals. Both parametric (Pearson product – moment correlation and t-test) and non-parametric (Mann-Whitney U test) methods were used for data analysis. Data was log-transformed for parametric tests.

Confounding variables of Elgar: According to Elgar (1989), food density is an important confounding variable influencing the relationship between flock size and vigilance behaviour. Variation in food density was not measured directly in this study, but the density of seeds on the stubble was not expected to vary much over the eight day period. Moreover, the significant correlation of peck rate (number of pecks per minute, $r = 0.16$, $N = 94$, NS) and proportion of time spent in feeding ($r = 0.13$, $N = 74$, NS) to flock size suggests that food density was not potentially important in the case of peafowl.

Competition within the group (Elgar 1989) did not seem to affect the vigilance behaviour, because aggression did not increase with flock size (proportion of time spent in aggression $r = 0.08$ $N = 60$, NS).

To verify the confounding influence of the ‘edge effect’ (Elgar 1989), positions of 27 individuals were categorized into 15 peripheral and 12 central positions. It was found that the proportion of time spent in vigilance ($t = 1.51$, $N = 27$, NS) was not affected by the individual’s position within the group.

Individual variation in foraging ability (Elgar 1989) was not pertinent here, because individuals were sampled randomly. Secondly, the individuals moved actively, changing their positions frequently.

Several studies have shown that sex may have a confounding effect on the relation between vigilance and group size (Elgar 1989), but none of the feeding and vigilance behaviour assessed differed significantly between males and females (Table 1b). Age and dominance might not affect the vigilance behaviour, as all observations were taken in the non-breeding season, when their group composition was mixed and fluid (Yasmin 1997).

Of the other confounding variables suggested by Elgar (1989), distance from cover (approx. 120 m), and time of day were constant. Variation in temperature was minor (18 °C to 22 °C) over the observation period. Breeding status, presence of predators, observer and habitat obstruction did not confound the results, because sampling was done in the non-breeding season, predators were absent, data was recorded from a fixed point and there was no visual or habitat obstruction as the peafowl were feeding in an open area.

Group size and Vigilance: Proportion of time spent in vigilance was inversely correlated to flock size ($r = -0.34$, $N = 74$, $P<0.01$). Vigilance rate ($r = -0.47$, $N = 94$, $P<0.001$) and duration of heads-up ($r = -0.69$, $N = 94$, $P<0.001$) were also inversely correlated to group size. Peck rate was inversely correlated to duration of time spent in vigilance ($r = -0.39$, $N = 94$, $P<0.001$).

Group size and Feeding behaviour: As stated above, none of the feeding behaviour parameters were correlated to flock size. However, when the peck rate and proportion of feeding time of individuals in three categories of group sizes were verified, the results showed that significant difference existed between the feeding behaviour of solitary individuals and individuals in larger flocks (Table 1a).

Inverse correlation of vigilance parameters with flock size suggests that increasing flock size helps the individual to scan less. By reducing the rate of scanning and time spent in vigilance, the birds can spend more time on feeding and feed faster. This was supported by the result that birds pecked faster and devoted more time to feeding in groups of larger sizes.

The negative correlation between peck rate and duration of vigilance also suggested that individuals do benefit in their foraging ability when in larger groups, because they need less time for vigilance, as in brent geese (*Branta bernicula*) (Inglis and Lazarus 1981), goldfinches (*Carduelis carduelis*) (Gluck 1987) and in carrion crows (*Corvus corone*) (Saino 1994).

TABLE 1
FEEDING AND VIGILANCE BEHAVIOUR MEASURES IN RELATION TO GROUP SIZES AND SEXES.

a) **Different group sizes**		
Measure	Single (N = 12) vs group size 2-5 (N = 38)	Single (N = 12) vs group size > 5 (N = 44)
Peck rate	U = 304.5*	U = 450***
Vigilance rate	U = 279 NS	U = 434.5***
Duration of vigilance	U = 353**	U = 479.5***
Measure	Single (N = 16) vs group size 2-5 (N = 38)	Single (N = 16 vs) group size > 5 (N = 26)
Proportion of time spent in feeding	U = 363 NS	U = 227*
Proportion of time spent in vigilance	U = 413.5*	U = 236.5*
b) **Male (N = 23) vs**	**Female (N = 15)**	
Measure	Group size 2-5	Group size > 5
Peck rate	U = 213.5 NS	U = 262 NS
Vigilance rate	U = 194 NS	U = 227.5 NS
Duration of vigilance	U = 185.5 NS	U = 246.5 NS
Proportion of time spent in feeding	U = 173.5 NS	U = 60 NS
Proportion of time spent in vigilance	U = 197 NS	U = 246.5 NS

Mann-Whitney U test, * = P<0.05, ** = P<0.01, *** = P<0.001

The increased feeding rate and proportion of time spent in feeding of peafowl in flocks over solitary conspecifics, in all the three ranges of flock size could either be due to intraspecific competition (Clark and Mangel 1986) or due to local enhancement (Krebs 1973, Morse 1977). Since aggression did not increase with increasing flock size, the intraspecific competition hypothesis is ruled out. The increased peck rate and proportion of time spent in feeding due to local enhancement seems to be true in peafowl. They were seen flying directly from roosts and

joining the feeding flocks in the crop field.

In conclusion, this study showed that in the range of group sizes considered, peafowl benefit from being in a flock, since peck rate and proportion of time spent in feeding in flocks were higher than those of solitary birds, and the individual time spent in vigilance decreased with flock size. However, the increase in feeding rate with flock size might not be linear and consistent. Peafowl flock in open habitat, and flocking seems to be adaptive, mainly with respect to high food availability and increased vigilance (Yasmin 1997). Nevertheless, foraging as a member of a group is more advantageous than feeding alone.

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10. EGGS IN THE DIET OF THE SARUS CRANE *GRUS ANTIGONE* (LINN.)

The sarus crane (*Grus antigone*) is well known to be an omnivore, feeding on grain of several kinds, shoots of plants, bulbs of aquatic plants, frogs, lizards and other reptiles, grasshoppers and other insects, fish, vegetable matter, fruits, and aquatic and terrestrial molluscs (Hume and Marshall 1879, Law 1930, Baker 1929, Ghorpade 1975). I had the opportunity to observe a sarus family in Haryana which has enabled me to make an addition to the known diet of the species.

On the morning of June 16, 1998, I was observing a pair of sarus cranes with a young chick foraging among the water hyacinth in the Bhindawas Wildlife Sanctuary, Haryana. The pair were characteristically keeping the chick between them as they moved around and occasionally, they would pick up a small crab

from among the water hyacinth and drop it in front of the chick. The male sarus suddenly reared its head and made a jabbing movement into the hyacinth with its open beak. It had chanced upon an incubating spotbill duck *(Anas poecilorhynchos)* which hurriedly took flight, calling loudly. The male began feeding on the eggs, and proceeded to swallow them one by one, lifting them, and raising its beak upwards. The female, meanwhile, herded the chick towards the nest and swallowed one egg. The male bird had swallowed four eggs continuously and a distinct bulge had formed at the top of the neck. The female then lifted one egg from the nest and dropped it on the ground near the chick and pecked at the egg to open it up for the chick to feed on. When the chick began feeding, the female moved towards the nest, broke open one egg and fed on the contents. The male regurgitated part of the eggs and the chick fed on this as well. The spotbill duck had, in the meanwhile, made several unsuccessful attempts to drive away the cranes from the nest by flying close and calling out loudly. The three cranes ate at least nine eggs during this observation. They stayed at the nest for over two hours after eating and preened themselves.

Eggs have never been known to be in the diet of the sarus crane. The adult birds are, however, reputed to feed the chicks on the egg shells just after hatching (A. R. Rahmani *pers. comm.*). This behaviour has been observed in the sand-hill crane (*Grus canadensis*) where the adult offers pieces of the egg shell directly to the chicks, or drops the pieces in front of them (Archibald and Meine 1996).

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11. CIRCUMSTANTIAL EVIDENCE OF BREEDING OF THE NILGIRI WOOD PIGEON *COLUMBA ELPHINSTONII* (SYKES) AT NANDI HILLS, NEAR BANGALORE

The Nilgiri wood pigeon *Columba elphinstonii* is known to occur in the Western Ghats complex including the Anamalais, Nilgiris, Palnis and the hills of western Mysore, where it affects moist evergreen forest from the foothills to the highest shola forests (Ali and Ripley 1983).

Outside this designated area, the Nilgiri wood pigeon *Columba elphinstonii* has been reported at the Nandi hills (13° 22' N, 77° 41' E) about 60 km north of Bangalore (Subramanya *et al.* 1994).

I visited Nandi hills on March 23, 1997. While bird watching in a clearing adjoining an evergreen patch, the sound of a snapping twig drew my attention. A pigeon flew out of the dense canopy of the evergreen patch into the open. It

alighted on a tree almost in the middle of the clearing, with the twig in its beak, about 6 m from the ground. When it moved to the centre of the tree, it was not visible until it flew out without the twig.

Subsequently, the Nilgiri wood pigeon was seen walking on the branches of nearby trees, moving towards the slender, dry twigs, balancing itself with great difficulty. On selecting the twig, it broke it off and carried it to the nesting tree.

Both individuals of the pair were seen carrying nesting material. One individual had the central rectrices missing, which made identification of the two individuals possible.

This observation of the Nilgiri wood pigeon at Nandi hills is significant, as it is the only breeding report of the species in the recent past.

November 9, 1998

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12. USE OF PLASTIC AS NEST MATERIAL BY GOLDEN ORIOLE *ORIOLUS ORIOLUS* (LINN.), FAMILY: ORIOLIDAE

While still following nest designs traditional of orioles, golden orioles in the Indroda Park have shown innovations in the selection of nest materials. Plastic sheets and tape have been added to 'grass and fast fibres bound with cobwebs', THE BOOK OF INDIAN BIRDS by Sálim Ali.

Uday Vora, DFO, Gandhinagar took me bird watching on Sunday, July 19, 1998, in the Indroda Park, Gandhinagar. The Park borders the Sabarmati river and is, in his words "a maternity home for birds". He has a keen eye for locating nests and had taken me to see a white paradise flycatcher incubating freshly laid eggs. The nest was up on a babool (*Acacia* sp.) tree, which had nests containing full grown chicks of a black drongo pair, a whitebrowed fantail flycatcher incubating eggs and a white eye on eggs. Nearby was a golden oriole's nest from which young had just flown, the family was in the vicinity. In another babool tree, again a black drongo nest associated with a paradise flycatcher's, this time with hatched chicks being fed by a chestnut male.

Further on, among eucalyptus trees he showed me two golden oriole nests, from both of which the chicks had flown — the birds were in the vicinity — the liquid calls of the males and the harsh responses of the females and the juveniles were continually heard. It was to these nests that Uday drew my attention. Glassing them, I confirmed a discoloured white piece of plastic sheet incorporated among the traditional fibres and grass in one nest, the other had plastic tape — the type used for tying packages — woven into the structure! The nests were some 8 m up in the sparsely crowned trees, both extremely exposed. I have suggested to Uday Vora to have the nest collected and the plastic material photographed.

July 30, 1998

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13. COMPETITION FOR FOOD BETWEEN A GARDEN LIZARD *CALOTES VERSICOLOR* (DAUDIN) AND A MAGPIE ROBIN *COPSYCHUS SAULARIS* LINN.

On April 6, 1998, at about 1230 hrs, I saw a garden lizard *Calotes versicolor* chasing a centipede *Scolopendra* sp. for a distance of about 10 m in a garden at Garigaon, Guwahati, Assam. The centipede was moving fast and the lizard was playing with it; it held the centipede and set it free many times. Suddenly, a magpie robin *Copsychus saularis* appeared, and attempted to steal the prey of the calotes. At this, the calotes became aggressive, standing up on its hind legs, holding the anterior portion of the body upright and attempting to bite the bird, but the bird moved smartly to avoid the attack.

Taking advantage of the interruption, the centipede started to move away, but as it was already injured, it could not make much headway before being sighted by the magpie robin. The bird now left the calotes alone, and tried to fly away with the centipede, but succeeded in getting only about half of the centipede — the calotes having retained the other half.

The magpie then sat about 5 m away and the calotes charged towards the bird, leaving its portion of the prey on the ground. This time the bird flew away, holding its portion of the centipede in its beak. To my astonishment, the calotes did not come back to regain its share of the kill.

Dec. 16, 1998

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14. PURPLERUMPED SUNBIRD *NECTARINIA ZEYLONICA* (LINN.) AT GANDHINAGAR, GUJARAT

In 'Birds of Gujarat — A Sálim Ali Centenary year overview' *JBNHS* 93(3), December 1996, I had this to say about this attractive little bird: '... resident bird watchers of Vadodara and Surat may well come across a good many more' in response to Sálim Ali's 'a single unconfirmed sight record.' I had always been puzzled why this otherwise common bird of the peninsular gardens was not more widespread and common in Gujarat, and I was happy to have recorded it in Ahmedabad a year ago (1997). For a month, I have been aware of sunbirds around my Gandhinagar home, emanating calls at a higher note and sounding more lisping, and I was sure I was not hearing the ubiquitous purple sunbird *N. asiatica,* but at 60, one does not place much credence on small variations of sound, and I have long ago lost the brashness of youth to jump to conclusions, however valid. Mark my joy then, at finding a pair of purplerumped sunbirds among a flock of other small garden birds chivvying our cat and her kitten, just outside my window. I took the opportunity to observe the female carefully. She had a considerably shorter and finer bill, showed a more distinctive yellow on the throat and breast, and had a black tail with rather prominent white ends to the outer feathers. This was in clear contrast to the female purple sunbird which looked more leggy and off colour. But these finer points are not to be relied on when birds are flitting around among tall trees. It is the variation of the call, that is very distinct and draws attention. This morning I saw the *zeylonica* feeding on my kadamb tree.

The question is — have we been overlooking this sunbird, which I doubt, or is the species expanding its range? An ecological

study of the requirements of the various species of *Nectarinia* would provide very interesting reasons for species sharing wide tracts as do *asiatica, zeylonica* and *lotenia,* with the former extending far beyond the other two. What factors delineate the ranges of species otherwise compatible?

To conclude, during an earlier visit to Mumbai, I had examined the sunbird specimens in the collection of the Society, and was surprised to note that the female purplerumped sunbirds had shorter and finer bills than the males!

October 10, 1998

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15. NESTING OF *PLOCEUS PHILIPPINUS* (LINN.) AND *PLOCEUS MANYAR* (HORSFIELD) ON MANGROVE AND ASSOCIATED SPECIES IN CORINGA WILDLIFE SANCTUARY, ANDHRA PRADESH

At Coringa Wildlife Sanctuary (*c.* 15° 17' N & 76° 26' E), Andhra Pradesh, we have recorded nests (both complete and incomplete 'practice nests') of the baya weaver bird *Ploceus philippinus* (Linn.) and streaked weaver bird *P. manyar* (Horsfield) on mangrove and associated species. Almost all the accessible creeks and canals crisscrossing the sanctuary were surveyed. In all, 72 nests of both types of each species were recorded, of which 19 were complete, and the rest incomplete 'practice nests'. Altogether, 5 species of nesting plants were noted, which were *Avicennia officinalis* L. — 12 complete and 3 incomplete nests of *P. philippinus*; *Clerodendron inerme* (L.) — 7 complete nests of *P. manyar; Dalbergia horrida* (Dennst). — 6 and 16 incomplete nests of *P. philippinus* and *P. manyar* respectively; *Acanthus ilicifolius* L. — 18 and 6 incomplete nests of *P. philippinus* and *P. manyar* respectively; and *Myrisosatchya wightiana* (Nees ex Steud.) Hk. f. — 4 incomplete nests of *P. manyar.*

It is interesting to note that all the complete nests were observed in the creek near human habitation, while the majority of incomplete 'practice nests' were observed far away, nearer the sea front.

C. Srinivasulu acknowledges financial assistance granted to him by the CSIR, New Delhi.

November 2, 1998

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16. FIRST RECORD OF *PSAMMOPHILUS BLANFORDANUS* (STOLICZKA 1871) (FAMILY: AGAMIDAE) FROM GUJARAT, INDIA

On December 8, 1998 at 1335 hrs, an olive-brown lizard was observed on a large rock along the dry bank of the Panam river (a tributary of Mahi), near Kanjeta village, Ratanmahal Wildlife Sanctuary (RWS), Panchmahal district (20° 31'-22° 35' N, 74° 11'-74° 33' E). It was identified with the help of diagnostic keys (Smith 1935) as Blanford's rock agama lizard (*Psammophilus blanfordanus*). In addition, two specimens of the same species have been collected from the rocky bed of the Terav river (a tributary of the Narmada), near Mal-Samot

villages, Shoolpaneshwar Wildlife Sanctuary (SWS), Bharuch district (21° 03' - 21° 59' N, 73° 05' - 74° 10' E).

This olive-brown lizard has a series of large oval-shaped spots on each side of the back, which are absent in the sub-adults. Marbled spotted markings on tail, limbs and lateral body region. Head pale brown and a black spot present on the forehead. A dark stripe is present from the nasal to the tympanum, on both sides of the head (BNHS Regn. Nos. 1441 and 1442). The measurements and other details are given in Table 1.

Psammophilus blanfordanus is distributed in the eastern part of central Gujarat, from SWS, Bharuch district towards the northeast, through the forests of Vadodara district (Nasavadi and Chhota Udepur tehsil) and up to Ratanmahal Wildlife Sanctuary, Panchmahal district of the adjoining Madhya Pradesh.

Local tribals, call it *sardo* or *kanchido*. The species is abundant in a few river valleys of SWS and RWS. A few lizards are arboreal. During the breeding season (April to August), males perform courtship displays upon large tree trunks 2-3 m high, similar to *Calotes* garden lizards.

According to Smith (1935) and Khajuria and Agrawal (1981), *P. blanfordanus* is distributed in India, from Hoshangabad, Madhya Pradesh to east Bihar and Orissa, Eastern Ghats, and up to south Thiruvananthapuram, Kerala. The present record from the eastern part of central Gujarat is a range extension.

August 3, 1999

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TABLE 1
MORPHOMETRIC DATA AND PHOLIDOSIS OF BLANFORD'S ROCK AGAMA (*PSAMMOPHILUS BLANFORDANUS*), GUJARAT STATE.

Details	Ratanmahal Wildlife Sanctuary	Shoolpaneshwar Wildlife Sanctuary	
Specimen BNHS Regn No.	1441	1442	-
Snout to vent length	4.8	7.0	5.5
Tail length	9.2	7.0 tail cut	10.7
Total body length	14.0	14.0+	16.2
Head length	1.2	1.2	1.3
Head width	1.1	1.6	1.05
A-G	2.08	3.9	2.09
ED	0.4	0.6	0.5
E-N	0.6	0.6	0.5
E-S	0.8	0.9	0.8
E-E	0.55	0.6	0.4
EL	0.30	0.35	0.30
Upper labial R/L	10/11	10/10	11/11
Lower labial R/L	10/11	10/10	10/11
Rostral covered with no. of scales	4	6	4
Snout covered scales	Keeled/unequal	Keeled/unequal	Keeled/unequal
Back scales	Keeled	Keeled	Keeled
Belly scales	Keeled	Keeled	Keeled
No. of scale rows on body	109	100	85
Hind limb digits lamellale,	11:15:18:20:13	8:15:21:24:17	10:17:20:23:17
Two separated spines on the back of the head	Present	Present	Present
Sex	Not determined	Male	Female

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17. REDISCOVERY OF TWO RARE TYPHLOPIDS, *TYPHLOPS THURSTONI* BOETTGER, 1890 AND *T. TINDALLI* SMITH, 1943 FROM KERALA

(*With four text-figures*)

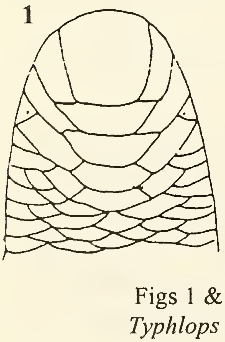
This is a report of the rediscovery of *Typhlops thurstoni* Boettger, 1890 and *T. tindalli* Smith, 1943 from Trichur district, Kerala state, southwestern India, during a herpetological survey conducted by the author.

Typhlops thurstoni Boettger, 1890

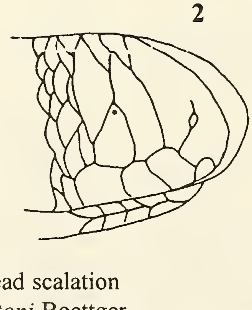
It was known from only four specimens in the Natural History Museum, London and one with the Zoological Survey of India (Murthy 1993). Unfortunately, collection details pertaining to the latter are not available. Originally described from the Nilgiris, it was reported from Trichur (Wall 1919) and from Wynaad in Kerala (Procter 1924). The present specimen was collected on August 18, 1997, from a coconut grove with laterite soil in Chavakkad, 28 km west of Trichur.

T. thurstoni is a small, active snake, light brown dorsally and pale brown ventrally, except for the snout and anal region which are whitish. The margins of the scales are darker. The snout is rounded and strongly projecting. The rostral is 2/3rd as broad as the head, and extends to the level of the ocular. The central portion of the rostral is studded with glands and is dark brown. The large nasal is incompletely divided by a suture starting from the second labial and ending just beyond the nostril. The anterior nasal is less than half the size of the posterior nasal. The prefrontal is half as broad as the head, in full contact with rostral, separating the posterior nasals. The frontal is as large as prefrontal, both are double the size of other body scales. Ocular and preocular shorter than nasal, the latter almost as broad as posterior nasal and in contact with prefrontal, frontal and supraocular, besides ocular and posterior nasal. Supraocular twice as broad as long. Smith (1943) stated that eyes are not 'distinguishable' in this species, but in the present specimen, they are distinguishable. The tail ends in a point. There are 20 scales around the body, the diameter of which is contained 71 times in the total length. Transverse scale rows: 481. Length: 215 mm. Diameter: 3 mm. The pholidosis is shown in Figs 1 and 2.

1



2



Figs 1 & 2: Head scalation
Typhlops thurstoni Boettger

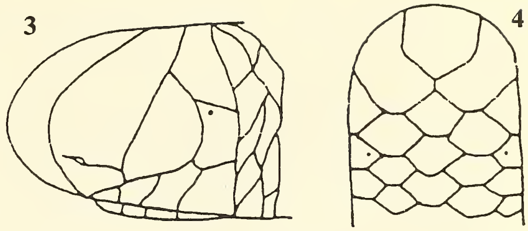
The present finding from Chavakkad was made 73 years after the last record by Procter (1924) from Wynaad.

Typhlops tindalli Smith 1943

T. tindalli was first reported from Nilambur in Kerala by Boulenger (1893) who identified

the specimen as *T. thurstoni.* Smith (1943) examined the three syntypes in the Natural History Museum, London and described them as *T. tindalli.* He also referred to *tindalli* Wall's (1919) specimen collected from Pilloor in Nilgiris and described as *T. beddomei.* Wall's specimen is lost and *T. tindalli* is known from the syntypes. Three more examples are with the Zoological Survey of India (Murthy 1993), but collection details are not available.

T. tindalli were collected from Kunnamkulam, 24 km west of Trichur on December 18, 1996 and between July 15 and 19, 1997, one from a kitchen garden and four from coconut plantations with laterite soil. These specimens are uniformly pink in colour, except for the snout and anal regions, which are whitish. In preservative, the colour turned yellowish-white. They are not as active or hardy as *T. thurstoni.* The snout is rounded and strongly projecting. The rostral is 3/5th the width of the head, posteriorly triangular, scarcely reaching halfway to the level of the ocular. The nasal is incompletely divided into anterior and posterior nasals by a suture passing from the preocular to beyond the nostrils, almost touching the rostral. Anterior and posterior nasals both in contact with preocular. The posterior nasal is four times as large as anterior nasal and in contact with its fellow behind the rostral. Ocular is less than half the size of the preocular and touching 3rd and 4th labials, but not wedged between them. Supraocular twice as broad as long. Prefrontal and frontal only marginally larger than body scales. Eyes small, but distinguishable while alive, though Smith (1943) stated that eyes are not distinguishable. The tip of the tail is slightly swollen and rounded without a spine. There are 18 scales around the body, the diameter of which is contained 60-70 times in the total length. Transverse scale rows: 364 to 395. The pholidosis is shown in Figs 3 and 4 and measurements in Table 1.

3  4

Figs 3 & 4: Head scalation
Typhlops tindalli Smith

TABLE 1
MEASUREMENTS OF *TYPHLOPS TINDALLI*

No.	1	2	3	4	5
Total Length	183	180	178	163	125
Diameter (mm)	2.5	2.5	2.5	2.5	2.0
Transverse Scale Rows	395	398	386	378	364

The present record has been made after an interval of 80 years since the last recorded finding by Wall (1919). While the earlier observations were from mountain areas such as Nilambur and Pillur in Nilgiris, at 600 m above msl, this record is an extension of range to the coastal plains of Kerala, over 100 km west of the known range.

The specimens of *T. tindalli* and *T. thurstoni* have been deposited in the Museum of the Wildlife Biology Dept, Kerala Forest Research Institute, Peechi, Kerala. Regn Nos KFRI (WL) R598 and R599, respectively.

ACKNOWLEDGEMENTS

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18. AMPHIBIAN FAUNA OF KUDREMUKH NATIONAL PARK, WESTERN GHATS, INDIA

In spite of the pivotal role played by amphibians in the trophic dynamics of various ecosystems, they have not been paid due attention in most biodiversity and ecological studies, especially in national parks and sanctuaries, where scientific studies are focussed on larger animals. India possesses a wide network of more than 69 national parks and 392 sanctuaries, covering about 4% of her geographical area (Nair 1996). However, amphibian studies have been done in a few sanctuaries and national parks only (Pillai and Pattabiraman 1991; Ray and Tilak 1994, Dueti 1996, George *et al.* 1996, Radhakrishnan 1996, Zacharias and Bhardwaj 1996). The Kudremukh National Park (KNP) (13° 10'-13° 26' N; 75° 5'-75° 10' E) is located in the central Western Ghats and covers Chickmagalur and Udupi districts of Karnataka. With a total area of 6,000 sq. km, the Park encompasses steep, densely forested slopes to gently undulating hills, with an average altitude of 1,000 m above msl), covers dense evergreen montane vegetation, shola forests, lowland forests and grasslands. A large number of streams, three major rivers, namely Tunga, Bhadra and Netravathi and their tributaries water the terrain. The Park is known for its thick and undisturbed vegetation, but the biotic information is largely restricted to its floristic composition (Pascal 1988) and a few reports of large animals. Daniels (1992) detailed amphibian distribution in the Western Ghats, but an extensive amphibian fauna of KNP is not available. Hence, we present this checklist of amphibians, compiled from the results of the survey of Kerekatte, Gangamoola, Kadambi, Bhagavathi Forest, Malleswara and Naravi regions of KNP during 1996-99.

All possible habitats of the study area during premonsoon (February to May), monsoon (June to September) and postmonsoon (October to January) were surveyed in all three years. The amphibians were identified in the field, and the species confirmed with the taxonomic keys of Boulenger (1890, 1920), Parker (1934), Taylor (1968), Daniel (1963, 1975), Daniel and Sekar (1989), as well as the latest field guides of Daniels (1997), and Bhatta (1998). Specimens were compared with those in the collection of the Zoological Survey of India, Southern Regional Station, Chennai. Overall, 26 species belonging to 4 families of Anura and 2 families of Apoda were recorded. Voucher specimens have been deposited in the Bombay Natural History Society, Mumbai. The list of amphibian species encountered, their number (N) in the sample and mean SVL ±sd., of the present study, are as follows:

Class: AMPHIBIA
Order: GYMNOPHIONA

I. Family: Ichthyophidae
Genus: *Ichthyophis* Fitzinger, 1826
1. ***Ichthyophis beddomei*** Peters, 1879
Habitat: Semi-aquatic, on the margins of seepage stream under thick forest canopy.
N=11; Mean Total Length ±sd: 209.4 ±37.68 mm; Range: 178.5-253.0 mm.
2. ***I. bombayensis*** Taylor, 1960
Habitat: Near the seepage stream under thick litter mat and organic mulch.
N=2; Mean SVL ±sd: 345.5 ±149.5 mm; Range: 198.0-495 mm.

II. Family: Caecilidae
Genus: *Gegeneophis* Peters, 1879
3. ***Gegeneophis carnosus beddomei*** 1870
Habitat: Semi-aquatic, beneath the boulder on the margin of a forest swamp in the forest.
N= 1; SVL 204 mm.

Order: ANURA

I. Family: Rhacophoridae
Genus: *Rhacophorus* Kuhl and Van Hasselt, 1822
4. ***Rhacophorus malabaricus*** Jerdon, 1870
Habitat: Arboreal, recorded in the thick leafy crown of bushes near a stream.
N=2; Mean SVL ±sd: 76.75 ±6.60 mm; Range: 72-86 mm.

Genus: *Philautus* Gistel, 1848
5. ***Philautus femoralis*** Günther, 1864
Habitat: Arboreal, bush dwelling.
N=1; SVL 19.50 mm.
6. ***P. charius*** Rao, 1937
Habitat: Recorded among forest floor litter.
N=6; Mean SVL ±sd: 20.25 ±1.41 mm; Range: 17.5-21.5 mm.
7. ***P. leucorhinus*** Lichtenstein & Martens, 1856
Habitat: Arboreal, bush dwelling.
N=2; Mean SVL ±sd: 30.5 ±2.83 mm; Range: 28.5-32.5 mm
8. ***P. glandulosus*** Jerdon, 1853
Habitat: Arboreal, collected from the bark.
N=2; Mean SVL ±sd: 28.25 ±0.35 mm; Range: 28.0-28.5 mm.

II. Family: Bufonidae
Genus: *Bufo* Linnaeus, 1758
9. ***Bufo melanostictus*** Schneider, 1799
Habitat: Grassland on the periphery of the shola forests.
N=3; Mean SVL ±sd: 66.34 ±3.3 mm; Range: 67-78 mm.
10. ***B. beddomei*** Günther, 1875
Habitat: Collected from the organic mulch on the floor of thick forest.
N=4; Mean SVL ±sd: 38.5 ±3.2 mm; Range: 34-43 mm.

III. Family: Microhylidae
Genus: *Microhyla* Tschudi 1838
11. ***Microhyla ornata*** Duméril & Bibron, 1841
Habitat: Semi-aquatic margins of paddy fields.
N=4; Mean SVL ±sd: 18.7 ±1.94 mm; Range: 16.5-21.0 mm.

IV. Family: Ranidae
Genus: *Rana* Linnaeus, 1758
12. ***Rana (Limnonectes) limnocharis*** Boie in Wiegmann, 1835
Habitat: Semi-aquatic, margins of the seepage stream, swamps associated with grass in open places.
N=6; Mean SVL ±sd: 34.5 ±4.03 mm; Range: 29-42 mm.
13. ***R. (Occidozyga) cyanophlyctis*** (Schneider, 1799)
Habitat: Aquatic, lentic waterbodies.
N=9 (8 were sub-adults). Mean SVL ±sd: 22.05 ±10.07 mm; Range: 10.5-47 mm.

14. ***R. (Limnonectes) keralensis*** Dubois, 1980

Habitat: Semi-aquatic, margins of watercourse.

N=4; Mean SVL ±sd; 57.0 ±10.3 mm; Range: 47-72 mm.

15. ***R. aurantiaca*** Boulenger, 1904

Habitat: Bush dwelling near the swamp.

N=2; Mean SVL ±sd: 33.0 ±2.9 mm; Range: 31-35 mm.

16. ***R. curtipes*** Jerdon, 1853

Habitat: Forest floor.

N=2; Mean SVL ±sd: 72 ±7.07 mm; Range: 67-77 mm.

17. ***R. (Indirana) semipalmata*** Boulenger, 1882

Habitat: Leaf litter and organic mulch on the margins of streams.

N=2; Mean SVL ±sd: 37 ±1.42 mm; Range: 36-38 mm.

18. ***R. temporalis*** Günther, 1864

Habitat: Semi-aquatic, margins of waterbodies.

N=3; Mean SVL ±sd: 52.4 ±5.3 mm; Range: 46.5-57 mm.

19. ***R. (Indirana) beddomii*** Günther, 1875

Habitat: Forest floor with thick, moist organic litter.

N=3; Mean SVL ±sd: 52.33 ±8.5 mm; Range: 44-61 mm.

20. ***R. (Limnonectes) tigerina*** Daudin, 1803

Habitat: Paddy field.

N=1; SVL 149 mm.

21. ***R. malabarica*** (Bibr.) Tschudi, 1838

Habitat: Forest-litter dwelling.

N=2; Mean SVL ±sd: 62.5 ±3.5 mm; Range: 59-69 mm.

Genus: *Tomopterna* Duméril & Bibron, 1841

22. ***Tomopterna (Sphaerotheca) rufescens*** Jerdon, 1854

Habitat: Along with grasses, in the litter and near decaying wood.

N=6; Mean SVL ±sd: 35.34 ±8.5 mm; Range: 31-40 mm.

23. ***T. (Sphaerotheca) breviceps*** Schneider, 1799

Habitat: Forest floor.

N=4; Mean SVL ±sd: 44 ±5.6 mm; Range: 38-53 mm.

Genus: *Nyctibatrachus* Boulenger, 1882

24. ***Nyctibatrachus major*** Boulenger, 1882

Habitat: Aquatic, seepage stream in the forest.

N=6; Mean SVL ±sd: 55.16 ±3.97 mm; Range: 49-60 mm.

25. ***N. aliciae*** Inger *et al.*, 1984

Habitat: Aquatic, seepage stream under thick canopy in the forest.

N=6; Mean SVL ±sd: 22.25 ±0.987 mm; Range: 20.5-23 mm.

Genus: *Micrixalus* Boulenger, 1888

26. ***Micrixalus saxicola*** Jerdon, 1853

Habitat: Aquatic, margins of seepage stream under thick forest canopy.

N=3; Mean SVL ±sd: 27.3 ±2.08 mm; Range: 25-29 mm.

Among these 26 amphibians, 20 species were found to be endemic to the Western Ghats. Amphibian diversity has been well documented for the rest of the Western Ghats and India (Inger and Dutta, 1986; Molur and Walker, 1998). However, the actual diversity is always greater than the known (Inger and Dutta 1986). Comparison of species diversity of KNP with the adjoining Sringeri region (Krishnamurthy and Katre 1993) reveals the occurrence of *Gegeneophis carnosus, Nyctibatrachus aliciae, Philautus femoralis, P. charius, Micrixalus saxicola* and *Tomoptera breviceps* in KNP, apart from those recorded for Sringeri region.

The occurrence of a large number of endemic species in KNP reflects the availability of congenial habitats and the possibility of more new amphibian species in future expeditions.

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19. ON A REPORT OF *PRISTOLEPIS MARGINATUS* JERDON (PERCIFORMES : PERCOIDEI : NANDIDAE) FROM KARNATAKA

The genus *Pristolepis*, belonging to the monotypic subfamily Pristolepidinae, Class Pisces, is restricted to a small area of peninsular India, Sri Lanka, Southeast Asia, and part of the Malay Archipelago (Nelson 1994). The type species *marginatus* Jerdon (1848) was described from the rivers of Mannantoddy in North Malabar, Kerala. Two species described subsequently from Travancore, namely *tetracanthus* Günther, 1862 and *malabaricus* Günther, 1854 and a subspecies from Wynaad, *malabaricus malabaricus* Silas, are all considered synonyms of *marginatus* (Talwar 1991, Menon in press). The only other species of this genus reported from India is *fasciatus* Bleeker, originally collected from the rivers of Borneo and is more widely distributed as follows: India: Kerala: Vembanad Lake; Myanmar, Thailand, Malay Peninsula, Sumatra, Borneo and Java. Menon (op. cit.) remarks that the occurrence of this species in Kerala needs confirmation.

Pristolepis marginatus was, until recently (Yadav, 1996), considered endemic to the Kerala part of the Western Ghats. It has since been collected from the Indira Gandhi Wildlife Sanctuary, Anamalai Hills, Tamil Nadu. Biju *et al.* (1999) reported its occurrence in the adjoining Parambikulam Reserve Forest in Kerala. During a faunistic survey of Karnataka, districts Dakshin Kannada, Kodagu and Biligiri Rangaswamy Wildlife Sanctuary, by a team from the Zoological Survey of India, 11 specimens varying in length from 41 to 91 mm SL were collected from altitudes ranging from 90 to 670 m.

Material collected: 1 ex. 41 mm SL, Regn No. F. 6052, 28.xi.1998, 640 m above msl, Haringi; 1 ex. 71 mm, F. 6072, 8.xii.1998, 670 m above msl, Gundiya; 1 ex. 18 mm, 11.iv.1999, 90 m above msl, Anjeri (Kollur); 5 exs 85 mm, F. 6106, 12.iv.1999, Bavanagare; 3 exs, 43 mm, F. 6116, 13.iv.1999, 90 m, Sowbarnika river. (All specimens bear three anal spines).

This is the first report of the species from the hill ranges of Karnataka. Its known northern limit is the Krishna drainage of Western Ghats (Yadav, op. cit.). There is a possibility of it being present in other waterbodies along the Western Ghats. The occurrence of this genus with Malayan affinities in different areas of the Western Ghats is of ichthyological significance (Hora 1944, Menon 1973).

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20. ON A REPORT OF *TETRAODON* (*MONOTRETUS*) *TRAVANCORICUS*, FROM SOUTH KANARA, KARNATAKA, INDIA

Two freshwater tetraodontid fishes have been described from India, namely *Tetraodon cutcutia* (Hamilton), found in the fresh waters of Bihar, Orissa, Bengal, and Assam, attaining a length of 9 cm and *Tetraodon* (*Monotretus*) *travancoricus* described from Pamba river, Central Travancore by Hora and Nair (1941), hardly attaining a length of 2.5 cm. After more than four decades, these miniature globe fishes were collected and reported from the coastal belts of Kerala, namely the Vembanad Lake, Kottayam by Ahlander (1998). Part of the collections made by him from Kottayam and adjacent districts of Kerala deposited in the Reserve collections of Zoological Survey of India, Southern Regional Station (ZSI, SRS), Chennai, included *T. travancoricus* from three localities, namely Meenachil river, Vembanad lake and from near Kottayam Railway Station (Rema Devi *et al.* 1996). A report on the sexual dimorphism of the species from Pudukkad, Trichur, Kerala was made by Inasu (1993). Occurrence in the Chalakudi, Periyar and Kechery rivers, Kerala was reported by Biju *et al.* (1999). Subsequently it was found further north in Karimpuzha, a tributary of Chaliyar river (north of the Palghat gap) by Lal Mohan (in press). The present record of these tiny tetraodontids far inland, from the waters of the evergreen forests of Western Ghats of South Kanara, is of ichthyological significance.

The collections were made during a survey by ZSI, SRS. The 10 specimens range in length from 10.00-18.5 mm SL, Regn No. F. 5845, from around Mavincar, Dakshin Kannada, at 50 m above msl, 13.iv.1999, coll. G. Thirumalai.

Other Material: 3 exs 14.5-20.00 mm SL, F.1364, Feb-Mar 1988, Shertallai, Kerala, V.C.R.C., Shertallai; 4 exs 15.5-19.5 mm SL, F. 5323, Karimpuzha, 22.i.1997, R.S. Lalmohan; 16 exs F.6005, 17.iv.1990, Vembanad lake, coll. Eric & Suzz.

DESCRIPTION

D.8(4) or 9(6); P.17(2) or 18(8); A.8(7) or 9(3); C 1/7(3), 8(6), 9(1)/2.

Morphometric characters are presented in Table 1. The proportions of the biometric characters of the specimens from Karnataka fall within the range given in the original description by Hora and Nair, 1941. However, though similar in position, the blotches on the body are smaller and have a restricted spread.

Remarks: Recently, a new species *Carinotetraodon imitator* was described from Cochin, Kerala by Britz and Kottelat (1999). The genus *Carinotetraodon* is distinguished from *Tetraodon,* in that the males of the former possess conspicuous mid-dorsal and mid-ventral keels on the skin during courtship, a character supposedly absent in species of *Tetraodon. C. imitator* is diagnosed by the presence of numerous, additional, tiny spots interspersed with larger blotches in females (vs. presence of only larger blotches in *Tetraodon*); body spination: a few slender pointed spines (vs. dense coverage); and differences in certain osteological

TABLE 1
MORPHOMETRICS OF *T. TRAVANCORICUS* FROM DAKSHINA KANNADA N=10

Characters	Range	Mean
Total length/Head length	3.06-3.33	3.17
Standard length/Head length	2.36-2.54	2.43
Height of head/Head width	0.93-1.12	1.03
Head length/Height of head	0.97-1.13	1.08
Length of head/Head width	1.01-1.24	1.12
Body depth/Head length	0.89-1.08	0.96
Head length/Eye diameter	2.39-2.98	2.61
Inter orbital width/Eye diameter	0.93-1.13	1.04
Total length/Body depth	3.03-3.54	3.30
Standard length/Body depth	2.32-2.70	2.52
Caudal peduncle length/ Caudal peduncle height	1.04-1.42	1.23
Total length /Caudal peduncle	3.86-4.50	4.24
Gill opening to Dorsal fin/ Head length	0.81-1.03	0.89

features. However, Britz and Kottelat (op. cit.) were not sure about the type locality, presuming it to be Cochin, based on the reports of aquarium traders. Though the new species is described as having some differences in the colour pattern (the presence of smaller spots in addition to large blotches) it remains to be seen whether this is only a colour variant. No two specimens of *T. travancoricus* studied by us showed the same colour pattern, as also mentioned by Hora and Nair (1941). From a comparative study of the colour pattern in specimens collected from various drainages along the west coast, we feel that colour is a highly variable character and cannot be relied on as a specific taxonomic feature. The meristic characters of the new species overlap with those of *T. travancoricus*, as evident from Table 2. Besides, the morphometric proportions of *C. imitator* fall within the range of *T. travancoricus*.

We feel that *C. imitator* as a species distinct from *T. travancoricus* deserves a second look, based on detailed studies of the secondary sexual characters, osteology and intraspecific colour variation within *travancoricus*.

The present study extends the range of distribution of the little known freshwater puffer fish *Tetraodon travancoricus* along a major stretch of the coastal belt of the Western Ghats, in several rivers which drain into the Arabian Sea, both above and below the Palghat Gap. It is probable that the species occurs in several other river systems, but escapes the attention of collectors due to its very small size. Further studies on the migratory habits, salinity tolerance and breeding behaviour of this euryhaline species should be carried out to ascertain the specific nature of colour pattern and spination, and to understand the origin and distribution of the species in the various habitats ranging from coastal brackish waters to the upper reaches of freshwater rivers.

TABLE 2
COMPARISON OF MERISTIC CHARACTERS OF *T. TRAVANCORICUS* FROM DIFFERENT LOCALITIES

Loc.	Pamba (Type Locality) (after Hora & Nair, 1941)	Dakshin Kannada (Present Collections)	Cochin, Kerala *C. imitator* Britz & Kottelat, 1999
D.	7-8	8-9	9-10
P.	16-17	17-18	17-19
A.	8	8-9	8-9
C.	9	10-12	11

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21. FISH FAUNA OF IDUKKI AND NEYYAR WILDLIFE SANCTUARIES SOUTHERN KERALA, INDIA

Kerala state, though small, has 44 rivers, and a large number of dams have been constructed across many rivers in order to use the water for irrigation and hydroelectric projects. These dams are mostly in the forests, hence their catchment areas have to be protected. Keeping this in mind, forests around many reservoirs of dams have been constituted as wildlife sanctuaries. Such sanctuaries are intended to ensure preservation of natural conditions necessary to protect nationally significant species, biotic communities or physical features of the environment (Basha 1997).

The freshwater fish fauna studies of sanctuaries and national parks in southern Kerala have gained the attention of various researchers in the past, of which several studies were conducted in the Periyar Tiger Reserve (PTR). Raj (1941a, b) described three new fish from Periyar lake, namely *Lepidopygopsis typus, Barbus* (*Puntius*) *ophicephalus* and *Barbus* (*Puntius*) *micropogon periyarensis*. Chacko (1948) listed 35 species of fishes from Periyar lake (PTR), and according to him mahseer (*Tor khudree*) is the commonest fish in the lake. Indra and Rema Devi (1990) collected 19 species from Thekkady Wildlife Reserve (PTR). Arun *et al.* (1996) recorded six species in addition to Chacko's (1948) list. Menon and Jacob (1996) described a new Cyprinid fish *Crossocheilus periyarensis* from PTR. Zacharias *et al.* (1996) collected 35 species from PTR. Very recently, Zacharias and Minimol (1999) reported *Nemacheilus menoni* as a new species from PTR. Fish fauna studies of Chinnar Wildlife Sanctuary were carried out by Easa and Shaji (1996) and Raju Thomas *et al.* (1999a). Recently Biju *et al.* (1999) recorded 40 fish species from the Parambikulam Wildlife Sanctuary. Ichthyofaunal studies of the Eravikulam National Park were undertaken by Raju Thomas *et al.*(1999b). The present study gives information on the status and distribution of fishes in the Idukki and Neyyar Wildlife Sanctuaries.

Idukki Wildlife Sanctuary is situated in Idukki district above the Idukki arch dam (9° 45'-9° 55' N; 76° 50'-77° 05' E). The Sanctuary is drained by Periyar river and its tributary Cheruthoni river. Idukki reservoir is formed by the construction of three dams across Periyar and Cheruthoni river. Cherian (1990) studied the impact of reduction in the water flow below the Idukki dams, in the Periyar river. Detailed studies conducted by Kurup (1983) on the dead

specimens from these waters in 1980-83 revealed that the fishes had died due to the high levels of toxicity in the water.

Neyyar Wildlife Sanctuary is the southernmost protected area of Kerala (8° 30'-8° 37' N, 77° 8'-77° 17' E). It is very near to Peppara WLS (north) and Agasthya Vanam Biological Park, Thiruvananthapuram district. The state boundaries of the Sanctuary are the Mundanthurai and Kalakkad Sanctuaries in Tamil Nadu (Nair 1991). This Sanctuary is drained by the Neyyar river and its tributaries.

TABLE 1
FISHES COLLECTED FROM IDUKKI NEYYAR WILDLIFE SANCTUARIES AND THEIR ABUNDANCE

S. No.	Species	Idukki	Neyyar
	I. Family: Anguillidae		
1.	*Anguilla bengalensis* (Gray)	++	+
	II. Family: Cyprinidae		
2.	*Catla catla* (Ham.)	++	++
3.	*Cyprinus carpio communis* Linn.	+++	++
4.	*Hypselobarbus curmuca* (Ham.)	+++	-
5.	*H. kurali* Menon & Rema Devi	++	++
6.	*Labeo rohita* (Ham.)	++	++
7.	*Barbodes carnaticus* (Jerdon)	++	++
8.	*B. sarana subnasutus* (Val.)	++	++
9.	*Puntius amphibius* (Val.)	+++	+++
10.	*P. arulius* (Jerdon)	-	+++
11.	*P. filamentosus* (Val.)	+++	+++
12.	*P. melanampyx* (Day)	++	++
13.	*P. ticto* (Ham.)	+++	-
14.	*Tor khudree* (Sykes)	+++	+++
15.	*Salmostoma boopis* (Day)	-	++
16.	*Barilius bakeri* Day	++	+++
17.	*B. gatensis* (Val.)	++	++
18.	*Danio aequipinnatus* (McClelland)	+++	++
19.	*D. malabaricus* (Jerdon)	-	+++
20.	*Parluciosoma daniconius* (Ham.)	++++	+++
21.	*Garra mullya* (Sykes)	+++	+++
	III. Family: Balitoridae		
22.	*Bhavania australis* (Jerdon)	++	++
23.	*Noemacheilus guentheri* Day	++	++
24.	*N. triangularis* Day	++	++
	IV. Family: Cobitidae		
25.	*Lepidocephalus thermalis* (Val.)	-	++
	V. Family: Bagridae		
26.	*Horabagrus brachysoma* (Günther)	+	-
27.	*Mystus armatus* (Day)	+++	++
28.	*M. malabaricus* (Jerdon)	-	++
29.	*M. oculatus* (Val.)	+++	++
30.	*M. vittatus* (Bloch)	+	-
	VI. Family: Claridae		
31.	*Clarias batrachus* Linn.	+	-
	VII. Family: Heteropneustidae		
32.	*Heteropneustes fossilis* (Bloch)	+	-
	VIII. Family: Siluridae		
33.	*Ompok bimaculatus* (Bloch)	++	++
34.	*Wallago attu* (Schneider)	++	++
	IX. Family: Sisoridae		
35.	*Glyptothorax madraspatanus* (Day)	+	-
	X. Family: Belonidae		
36.	*Xenentodon cancila* (Ham.)	++	++
	XI. Family: Aplocheilidae		
37.	*Aplocheilus lineatus* (Val.)	+++	+++
	XII. Family: Nandidae		
38.	*Pristolepis marginata* Jerdon	-	++
	XIII. Family: Ambassidae		
39.	*Parambassis thomassi* (Day)	+++	++
	XIV. Family: Cichlidae		
40.	*Etroplus maculatus* (Bloch)	+++	+++
41.	*E. suratensis* (Bloch)	++	+
42.	*Oreochromis mossambica* (Peters)	+++	+++
	XV. Family: Gobidae		
43.	*Glossogobius giuris* (Ham.)	++	-
	XVI. Family: Channidae		
44.	*Channa marulius* (Ham.)	++	+
45.	*C. orientalis* (Bloch & Schneider)	+	+
	XVII. Family: Mastacembelidae		
46.	*Mastacembelus armatus* (Lacepede)	++	++
	Total	40	38

(+) = Very rare, (++) = Rare, (+++) = Common, (++++) = Very common, (-) = Absent

Samples were collected from October 1998 to April 1999 to study the status and distribution of fish fauna. Sampling was done using cast nets, hooks and a modified form of cast net for small fish. The specimens were preserved in 10% formalin.

A total of 40 species belonging to 16 families and 29 genera were collected from the Idukki Sanctuary, and 38 species belonging to 13 families and 26 genera were recorded from the Neyyar Sanctuary (Table 1). Three culture fishes were collected from both the sanctuaries. Most of the species are widely distributed in Kerala and other parts of the Western Ghats. The following eight species were collected only from the Idukki WLS: *Hypselobarbus curmuca, Puntius ticto, Horabagrus brachysoma, Mystus vittatus, Clarias batrachus, Heteropneustes fossilis, Glyptothorax madraspatanus* and *Glossogobius giuris*. A few species were collected only from the Neyyar WLS, namely *Puntius arulius, Danio malabaricus, Salmostoma boopis, Lepidocephalus thermalis, Pristolepis marginata* and *Mystus malabaricus*. The abundance of these species is given in Table I. *Hypselobarbus curmuca* was seen abundantly in Idukki WLS and *Tor khudree* was collected in plenty from Idukki reservoir and below Meenmutty waterfalls, Neyyar WLS. *Glyptothorax madraspatanus, Clarias batrachus, Heteropneustes fossilis, Horabagrus brachysoma, Channa orientalis* and *Mystus vittatus* were found to be very rare in the Idukki WLS. In Neyyar WLS, the very rare species were *Anguilla bengalensis, Etroplus suratensis, Channa marulius* and *C. orientalis*.

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22. *ECTEINASCIDIA SLUITERI* HERDMAN (PEROPHORIDAE), A NEW RECORD OF A COLONIAL ASCIDIAN (PROCHORDATA) TO INDIAN WATERS

(*With one text-figure*)

A colonial ascidian, *Ecteinascidia sluiteri* Herdman 1906 is reported for the first time from Ervadi coast of Tamil Nadu, India. So far only 4 species of the genus *Ecteinascidia* are reported from India (Das 1938; Renganathan 1984, 1986; Renganathan and Krishnaswamy 1985). Of these, *Ecteinascidia bombayensis* was reported from the west coast, whereas the other three species, *Ecteinascidia garstangi, E. imperfecta, E. krishnani* were from the east coast. The specimen studied has been deposited in the National Collections of the Zoological Survey of India, Chennai (AS. 16).

Ecteinascidia sluiteri Herdman 1906

Occurrence and distribution: A few individuals of a damaged colony attached to calcrete stones were collected from the littoral zone of the Ervadi coast (9° 11' N; 78° 43' E). This species has been previously reported from Sri Lanka (Herdman 1906), Palau Islands (Tokioka 1950), Singapore (Millar 1975) and Australia (Kott 1985).

Synonymy: *Ecteinascidia sluiteri* Herdman, 1906, p. 300. Tokioka, 1950, p. 126. Millar, 1975, p. 267. Kott, 1985, p. 98.

Taxonomy: Class: Ascidiacea, Order: Enterogona, Suborder: Phlebobranchia, Family: Perophoridae, Genus: *Ecteinascidia,* Species: *sluiteri.*

Description: The colony consists of upright zooids, 0.7 x 0.3 cm, attached by a short stalk from the posteroventral corner of the body to a common basal mat of stolons. Branchial aperture terminal and atrial aperture subterminal. Both apertures on very low, conical siphons and have inconspicuous lobes. Test transparent, firm, naked. Zooids are pale green in life, but become colourless in preservative.

The body wall is thin, delicate, vascularised, and the arrangement of muscles is peculiar, in that the transverse muscles are short and grouped to form three longitudinal bands (one mid-dorsal and two lateral). On the left side, the band does not extend beyond the gut loop. Circular and longitudinal muscles are present

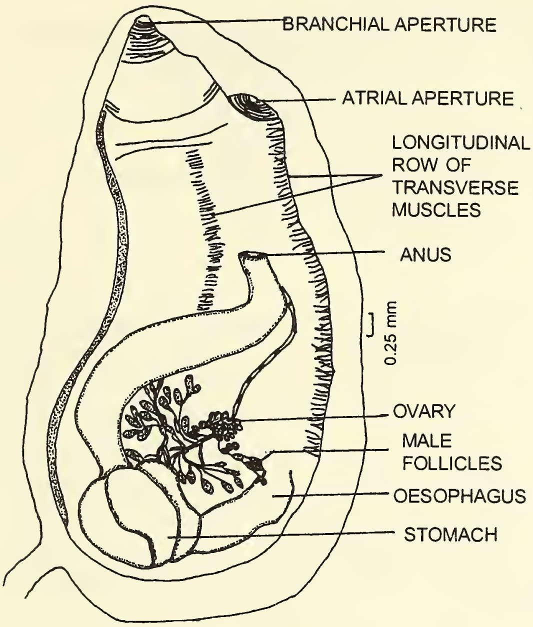

Fig. 1: *Ecteinascidia sluiteri* Zooid from left side showing gut loop, gonads and musculature

in the siphons. The dorsal tubercle has a simple opening. The dorsal lamina has small triangular languets with a membrane connecting them. 14 rows of 35-40 stigmata in each row. 2 stigmata in a mesh. Oesophagus at the posterior end of the branchial sac, leads to a large spherical stomach with oblique ridges. A gastrointestinal duct is present. The mid-intestine curves dorsally and forms a wide open loop. Rectum extends anteriorly at right angles to the descending limb of the intestine. The anterior pole of the gut loop is at the level of the 10th transverse vessel. The anus has a smooth border and lies near the 8th transverse vessel. Gonads are present in the gut loop. The male follicles are pear-shaped, arranged behind the small rounded ovary. No larva was observed (Fig. 1).

Ecteinascidia species are distinguished by the position of the apertures, body musculature, gut loop, and arrangement of gonads. The present species differs from those species of *Ecteinascidia* which have already been reported from India in the presence of three groups of longitudinal muscle bands rather than a continuous band as is present in the latter. The Indian specimen agrees well with the description of *Ecteinascidia sluiteri* from Sri Lanka, Singapore, Palau Islands and Australia in almost all characters, but differs from the Australian specimens in having only 14 rows of stigma rather than 22, as reported by Kott (1985).

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23. ADDITIONAL NOTES ON A HIMALAYAN SATYRID *DALLACHA HYAGRIVA* (MOORE) FAMILY SATYRIDAE, LEPIDOPTERA

(*With five text-figures*)

The type species *hyagriva* Moore of the monotypic genus *Dallacha* Moore (Smith, 1993; Varshney, 1994) has been reported earlier under the genus *Erebia* Dalman by Bingham (1905), Evans (1932), Talbot (1947), Wynter-Blyth (1957) and Mani (1986). Its distribution has been recorded from various Himalayan localities, such as Darjeeling, Kulu, Mussoorie, Simla and Kumaon (Marshall and de Niceville, 1883; Mackinnon and de Niceville, 1897; Evans, 1932; Wynter-Blyth, 1940; Talbot, 1947). Marshall and de Niceville (loc. cit.) have also stated that "*hyagriva* Moore was originally described from Darjeeling, but we have only as yet received it from the Western Himalayas, where it does not appear to be common." During the present survey, we could collect it from certain new localities, such as Kumarsain (2 males, 1 female, 8.ix.1992), Taklech, Rampur (1 female, 12.ix.1992), and Chowai (1 male, 13.ix.1992) in the Western Himalaya. An illustrated account of the male and female genitalia is given below in order to facilitate diagnosis.

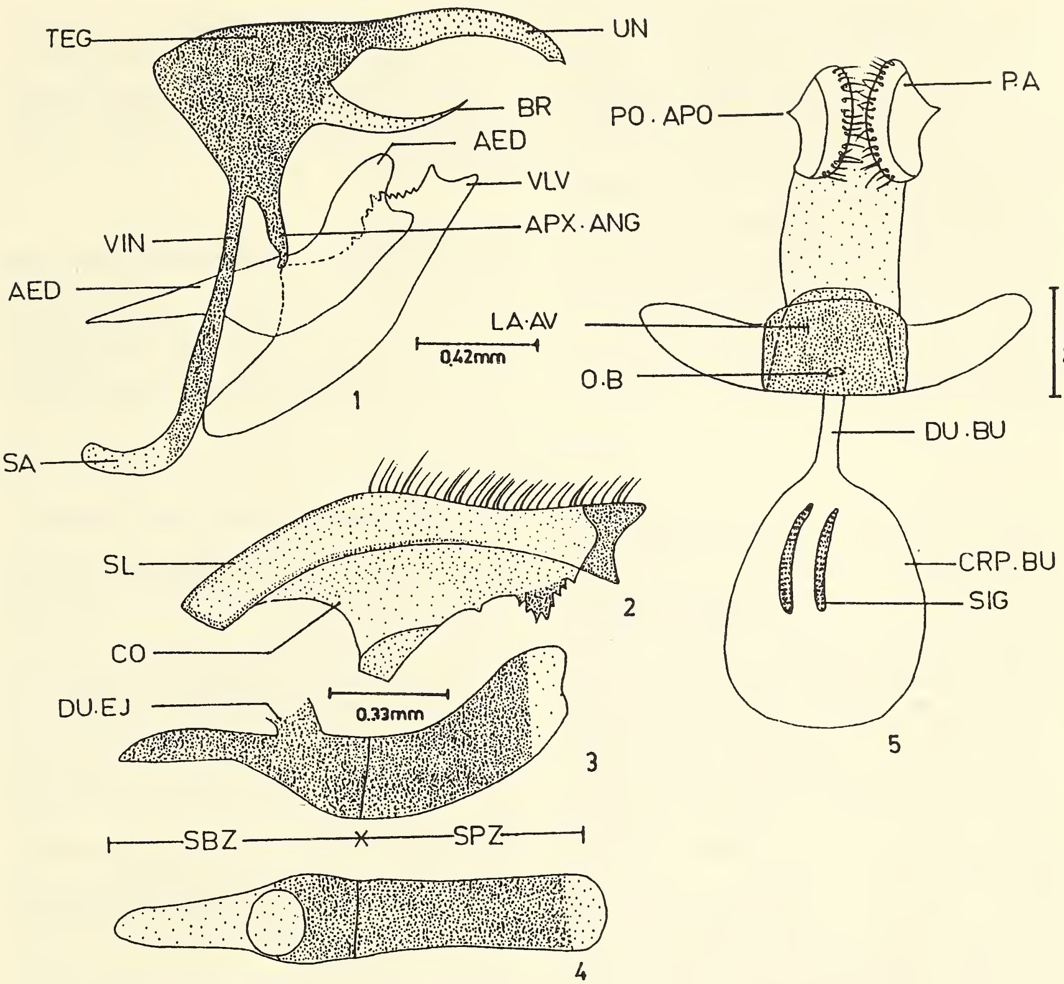
Brown Argus ***Dallacha hyagriva*** (Moore)
Moore, 1857, in Horsfield & Moore,
Cat., Lep. Inds. E. India Co. 1: 236.

Male genitalia: (Figs 1-4): Uncus longer than tegumen, curved ventrally, distal end sharply pointed; brachia more than half the length of uncus, finely pointed distally; tegumen broad; appendices angulares moderately long with distal end narrow; vinculum longer than tegumen; saccus short, tubular, rounded; valva broader in the middle, costa distinct with a smaller costal process, sacculus long and narrow, distal end concave, the latter beset with eight dorsal spines present near distal end; aedeagus long and broad, curved in the middle, subzone smaller than suprazone, ductus entering dorsad.

Female genitalia: (Fig. 5) Corpus bursae globular, membranous; signa paired and moderately long, represented by parallel scobinate patches, lying longitudinally in the posterior half of corpus bursae; ductus bursae shorter than corpus bursae, membranous; lamella antevaginalis with rectangular, plate-like, conspicuous central process, below which another slightly longer process, the latter lateral, broad, flap-like membranous; lamella postvaginalis inconspicuous; apophyses anterioris missing, apophyses posterioris reduced; papilla analis elongated, pilose.

Length of forewing Male: 21.0 mm
Female: 25.0 mm

The present study shows that the male genitalia of the type species *hyagriva* Moore of the genus *Dallacha* Moore are different from the type species *Erebia ligea* Linn. and *Ypthima huebneri* Kirby of the genera *Erebia* Dalman and *Ypthima* Huebner respectively (Warren, 1930, 1936; Rose and Sharma, 1999) under which it has earlier been synonymised by Talbot (1947) and Bingham (1905)



Figs 1-5: *Dallacha hyagriva* (Moore): 1. Male genitalia (lateral view) 2. Valva (inner view) 3. Aedeagus (lateral view) 4. Aedeagus (dorsal view) 5. Female genitalia (ventral view).

respectively. In the former species, the uncus is longer than the tegumen, and convex in shape and the same is straight and shorter than the tegumen in the latter species. In *ligea* Linn., the brachial area is parallel to the uncus and the aedeagus is straight or slightly undulating, whereas the brachia do not run parallel to the uncus and the aedeagus is strongly curved in *hyagriva* Moore. In *huebneri* Kirby, the brachia are completely wanting and the aedeagus rather weakly curved. The female genitalia of *D. hyagriva* (Moore) and *Y. huebneri* Kirby are also different from each other. In *Y. huebneri* the signum is absent, and the genital plate is very complex, whereas the paired signa are present and the genital plate is simple in *D. hyagriva*.

ABBREVIATIONS

AED: Aedeagus, APX.ANG: Appendix angularis, BR: Brachium, CO: Costa, CRP. BU: Corpus bursae, DU.BU: Ductus bursae, DU.EJ: Ductus ejaculatorius, LA.AV: Lamella antevaginalis, O.B: Ostium bursae, P.A.: Papilla analis, PO.APO: Apophysis posterioris, SA: Saccus, SBZ: Subzonal portion of aedeagus, SIG: Signum, SL: Sacculus, SPZ: Suprazonal portion of aedeagus, TEG: Tegumen, UN: Uncus, VIN: Vinculum, VLV: Valva.

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24. AN AGGREGATION OF BUTTERFLIES AT HYDERABAD, ANDHRA PRADESH

Butterflies are known to be closely associated with plants. They are attracted to flowers for nectar, and their developmental stages are often spent on them. Barnes (1939) observed that a large number of danaid butterflies are attracted to *Cynoglossum denticulatum* at Biligirirangan hills, Karnataka. Wynter-Blyth (1957) reported that butterflies are attracted to the trees of *Bridelia* in the Himalaya, and to *Poinsettia* and *Moringa* at lower elevations. Amladi (1975) noted that danaid butterflies are attracted to *Heliotropium indicum* plants. Chaturvedi and Satheesan (1979) published a note on the congregation of butterflies on *Crotalaria retusa* in the Western Ghats, while Larsen (1986) observed a dry season aggregation of these insects in Corbett National Park, Uttar Pradesh. Subsequently Jafer, Mathew and

Zacharias (1997) recorded an aggregation of butterflies on *Crotalaria peduncularis* and *H. indicum* plants in the Periyar Tiger Reserve, Kerala. This paper reports butterfly aggregation seen in the Nehru Zoological Park, Hyderabad, Andhra Pradesh.

On April 26, 1998, an exceptionally hot day in Hyderabad, with the ambient temperature hovering around 40 °C, the author visited the Nehru Zoological Park, about 10 km southwest of Hyderabad city. The Park has a land area of *c.* 300 ha, with lush green cover, dominated by trees like *Cassia auriculata, Albizia lebbeck, Azadirachta indica,* and *Polyalthia pendula.* At about 1000 hrs, near the guest house on the bank of the Mir Alam Tank, an extraordinarily large number of butterflies was observed.

The butterflies were not confined to any particular plant species, though the majority of them — mainly species like *Euploea core* (Common Crow) and *Tirumala limniace* (Blue Tiger) showed affinity to the small white flowered *Cestrum diurnum* (day jasmine) which is common in the area. The other plants growing nearby like *Tecoma stans* (yellow elder), *Catharanthus roseus* (Madagascar periwinkle), *Nerium indicum* (oleander), *Euphorbia tithymoides, Clerodendrum inerme, Lantana camara, Annona squamosa, Bougainvillea* sp. were also partially covered by these butterflies.

In addition to these butterflies, *Pachliopta hector* (Crimson Rose), *Papilio polytes* (Common Mormon) *Papilio clytia dissimilis* (Common Mime), *Danaus genutia* (Striped Tiger), *Danaus chrysippus* (Plain Tiger), *Hypolimnas bolina* (Great Eggfly), and *Eurema hecabe* (Common Grass Yellow) were also observed in the congregation. These butterflies were resting on the leaves, flowers and stems of the plants.

Incidentally, on May 31, at around 1030 hrs, the author observed similar swarms flying around the plants in the area. At that time, the *Cestrum diurnum* plant bore fruit, and most other plants were without leaves. It was noticed that honey bees (*Apis dorsata*), ants, wasps and metallic green Scutellarid bugs (*Chrysocoris* sp.) also congregate on the leaves, along with butterflies. It can be assumed that the cool and shady corner of the garden, which is regularly sprinkled with water by the zoo authorities during the summer, attracted these insects. A list of the butterflies seen during the two visits is given in Table 1.

TABLE 1
BUTTERFLIES OBSERVED IN THE AGGREGATION

Butterfly Family/Species	Approximate Numbers On 26.iv.98	On 31.v.98
Papilionidae		
Pachliopta hector (Linnaeus) (Crimson Rose)	12	-
Papilio polytes polytes Linnaeus (Common Mormon)	2	-
Papilio clytia f. *dissimilis* Linnaeus (Common Mime)	4	-
Graphium agamemnon (Linnaeus) (Tailed Jay)	-	2
Eurema hecabe (Linnaeus) (Common Grass Yellow)	2	-
Danaidae		
Danaus chrysippus (Linnaeus) (Plain Tiger)	4	2
Danaus genutia (Cramer) (Striped Tiger or Common Tiger)	8	3
Tirumala limniace Gmelin (Blue Tiger)	150	100
Euploea core (Cramer) (Common Crow)	200	150
Nymphalidae		
Hypolimnas bolina Drury (Great Eggfly)	2 ♀	3 ♀

Subsequently, on April 9 and May 8, 1999, the author visited the same area, but no butterfly species was observed.

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Biological Station, ZSI, Hyderabad for facilities and encouragement. I also thank Mr. V.V. Sivan, Centre for Ecological Sciences, Indian Institute of Science, Bangalore for identification of the plant species.

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25. NEW HOST PLANTS FOR TWO TROPICAL BUTTERFLIES AT VISAKHAPATNAM, ANDHRA PRADESH

During our investigations on the life-history strategies and larval performance of various butterfly species distributed in the environment of Visakhapatnam, a growing industrial city, we have recorded new host plants for the larvae of the Lemon Pansy *Junonia lemonias* (Linn.), Family Nymphalidae and the Common Yellow butterfly *Terias hecabe* (Linn.), Family Pieridae.

J. lemonias was found to lay eggs on *Asystasia gangetica* (Linn.) T. Anders (Acanthaceae), and all the five larval stages were found to feed on the leaves of *A. gangetica.* This is a new host plant, the known species being *Nelsonia campestris, Asteracantha longifolia* (Acanthaceae), and *Sida rhombifolia* (Malvaceae) (Wynter-Blyth 1957, BUTTERFLIES OF THE INDIAN REGION).

T. hecabe was observed to deposit eggs and the larvae to feed on the leaves of *Samanea saman* (Jacq.) Merril, *Mimosa pudica* (Linn.), *M. torta* Roxb., and *Peltophorum pterocarpum* (DC.) Baker ex Heyne (Caesalpiniaceae). Earlier, Wynter-Blyth (1957) listed *Cassia tora, C. fistula, Wagatea spicata* (Caesalpiniaceae), *Pithecolobium dulce, Albizzia* sp. (Mimosaceae), and *Sesbania aculeata* (Fabaceae) as the larval hosts of *T. hecabe.*

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26. SOME FRESHWATER MOLLUSCS FROM EASTERN AND CENTRAL NEPAL

(*With one text-figure*)

Nepal is a Himalayan kingdom, situated between 26° 30' N and 30° 15' N and between 80° 00' and 88° 15' E. A perusal of the literature shows a paucity of information on the molluscs

TABLE 1
MOLLUSCAN SPECIES OF NEPAL WITH THEIR DISTRIBUTION IN DIFFERENT DISTRICTS

Family/Genus	Species	Form	Site of Collection								
			Jha	Mor	Sun	Sap	Ud	Il	Kath	Lal	Dh
VIVIPARIDAE											
Bellamya	*bengalensis* (Lamarck, 1822)	f. *typica*	+	+	+	+	+	+	+	+	+
Bellamya	*bengalensis* (Kobalt, 1909)	f. *nepalensis*	+	+	+	+	+	-	-	-	-
Bellamya	*dissimilis* (Müller, 1774)	—	-	-	-	-	-	-	+	+	-
THIARIDAE											
Thiara (*Melanoides*)	*tuberculata* (Müller, 1774)	—	+	+	+	+	-	-	-	-	-
Thiara (I)	*scrüba* (Müller, 1774)	—	+	+	+	-	-	+	-	+	+
Thiara (Tarebia)	*granifera* (Lamarck, 1822)	—	+	+	+	-	-	-	-	-	-
Brotia	*costula* (Rafinesque 1833)	—	+	+	+	+	-	-	+	-	-
Paludomus (P)	*blanfordiana* (Neville, 1877)	—	+	+	+	+	-	-	-	-	-
PILIDAE											
Pila	*globosa* (Swainson, 1822)	—	-	+	+	-	-	-	-	-	-
Pila	*theobaldi* (Henley, 1875)	—	-	+	+	-	-	-	-	-	-
LYMNAEDAE											
Lymnaea (Pseudosuccinea)	*acuminata* (Lamarck, 1822)	f. *typica*	+	+	+	+	-	-	+	+	-
Lymnaea	*luteola* (Lamarck, 1822)	f. *typica*	+	+	+	-	+	-	-	-	+
Lymnaea (*Pseudosuccinea*)	*luteola* (Gray, 1822)	f. *ovalis*	+	+	+	+	+	-	-	-	+
Lymnaea (*Pseudosuccinea*)	*luteola* (Deshayes, 1834)	f. *succinea*	-	+	+	+	-	-	+	+	-
Lymnaea (*Galba*)	*andersoniana* (Neville, 1881)	—	-	-	-	-	-	-	+	+	-
Lymnaea (Galba)	*hookeri* Reeve, 1850	—	+	+	+	-	-	-	-	-	-
PLANORBIDAE											
Indoplanorbis	*exustus* (Deshayes, 1834)	—	-	+	+	+	+	+	-	-	-
Gyraulus	*convexiusculus* (Hutton, 1849)	—	-	+	+	+	-	-	+	+	-
PHYSIDAE											
Physa	*acuta* (Draparnaud, 1801)	—	-	-	+	-	-	-	-	+	-

TABLE 1 (*contd.*)
MOLLUSCAN SPECIES OF NEPAL WITH THEIR DISTRIBUTION IN DIFFERENT DISTRICTS

Family/Genus	Species	Form	Site of Collection								
			Jha	Mor	Sun	Sap	Ud	Il	Kath	Lal	Dh
UNIONIDAE											
Lamellidens	*marginalis* (Lamarck, 1819)	—	+	+	+	+	+	+	-	-	-
Lamellidens	*corrianus* (Lea, 1834)	—	-	+	+	+	-	-	-	-	-
Lamellidens	*jenkisianus* subsp. *obesa* (Hanley & Theobald, 1877)	—	-	+	+	-	-	-	-	-	-
AMBLEMIDA											
Parreysia (Radiatula)	*bonneaudi* (Eydoux 1838)	—	-	+	+	-	-	-	-	-	-
Parreysia (Radiatula)	*caerulea* (Lea, 1831)	—	+	+	+	+	-	-	+	+	-
Sphaerium	*indicum* · (Deshayes, 1854)	—	-	-	-	-	-	-	+	+	-

Abbreviations: Il - Ilam, Jha - Jhapa (Mechi zone); Mor - Morang, Sun - Sunsari, Dh - Dhankuta (Koshi zone); Sap - Saptari, Ud -Udayapur (Sagarmatha zone), Kath - Kathmandu, Lal - Lalitpur (Bagmati zone)

of Nepal. Godwin-Austen (1910) and Majupuria (1981-1982) have reported a few species of land and freshwater molluscs collected from Nepal's Kathmandu valley. This paper presents a list of the freshwater molluscs collected during a survey of nine districts, representing four zones of Nepal. The survey was initiated in 1993, to make a comprehensive checklist of the molluscan species of Nepal and continues to be done twice a year, during August-September and December-January.

The molluscs of 9 districts, namely Ilam, Jhapa, Morang, Sunsari, Dhankuta, Saptari, Udayapur, Lalitpur, and Kathmandu, representing four zones (Mechi, Koshi, Sagarmatha and Bagmati) of Nepal, were collected from various waterbodies, such as ponds, ditches, lakes, and channels (Table 1). A nylon net was used to collect live molluscs from water, while the dry shells were hand picked. The colour and morphology of the fresh and dry specimens along with their habitat and sites of collection were recorded. Live specimens were preserved in 5% formalin for further identification. Preston (1915), Tonapi (1980), and Subba Rao (1989) were used to identify the specimens. Identifications were confirmed by the Zoological Survey of India, Calcutta.

A total of 25 species of freshwater molluscs were recorded in nine districts, of which 19 were gastropods and 6 belonged to Bivalvia (Pelecypoda). The molluscan species and their collection sites are given in Fig. 1.

Of the 25 species in this collection, only 2, namely *Bellamya bengalensis* f. *nepalensis* (Kobalt 1909) and *Lymnaea (Galba) andersoniana* (Neville 1881) have already been reported from Nepal (Subba Rao, 1989).

Some of the species were abundant at some sites, but rare or absent at others. This appeared to be due to the diverse climatic and ecological conditions of the collection sites. For instance, *Bellamya bengalensis* f. *nepalensis* and *Lymnaea (Galba) andersoniana* were abundant in Lalitpur and Kathmandu, but not recorded in any other area. Likewise, *Bellamya dissimilis* and *Bellamya bengalensis* f. *typica* were abundant in the ponds of Jhapa, Morang, Sunsari and

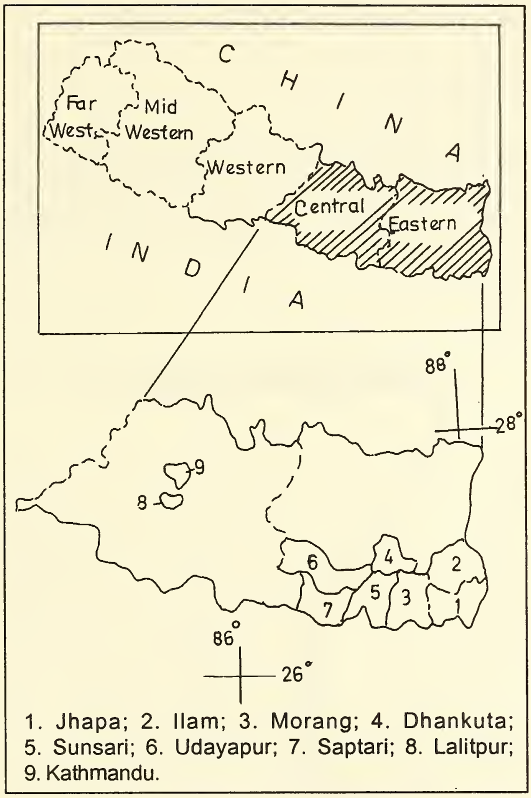

Fig. 1: Distribution of freshwater molluscs in the eastern and central regions of Nepal.

Saptari (all in the Terai region), but they were rare in Ilam and Dhankuta (all in hilly areas). *Physa acuta* was recorded in Morang as well as in Lalitpur district. *Sphaerium indicum* was recorded only in Lalitpur district. However, overlapping and uneven distribution of molluscan fauna is common. As this report is from a study area of nine districts of Nepal out of a total of 75, nothing can be said conclusively about their distribution. Further studies may indicate their distributional trends. Three other zones (Janakpur, Narayani and Gandaki), covering 12 districts have already been surveyed and the collection is being studied.

Acknowledgements

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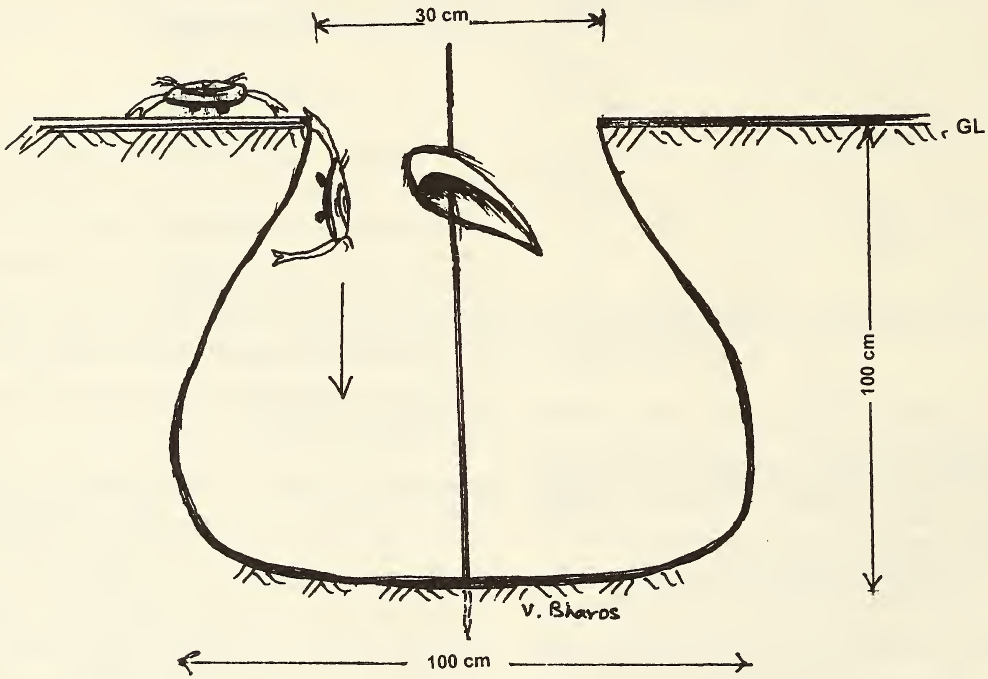
27. AN INTERESTING METHOD OF CATCHING MARINE CRABS

(*With one text figure*)

While wanderings on the beaches of Harne, Dabhol and Devgarh, in Ratnagiri in the Konkan region of Maharashtra, I observed an interesting method of trapping marine crabs.



The trapper digs a small pitcher-shaped pit with an opening of about 30 cm to 40 cm diameter and about 1 m deep in sandy beaches, mostly near mangroves (Fig. 1).

To attract the crabs, the ear of a butchered goat or sheep is placed in each pit at the bottom, fixed with a bamboo spike. With time the flesh starts decomposing, attracting the crabs. No sooner than the crabs approach the pit and attempt to reach the rotting flesh, they fall inside and get trapped.

The catch is collected by the trapper early in the morning and taken to the market for sale.

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28. ON THE OCCURRENCE OF *LEEA MACROPHYLLA* ROXB. (VITACEAE) IN RAJASTHAN STATE

During a botanic exploration conducted from August 24 to 25, 1993, I observed a number of *Leea macrophylla* plants between "Bhagya Baori" (Bhagi Baori) and Sitamata temple in Sitamata Wildlife Sanctuary, Chittorgarh district, Rajasthan. Most of the plants were observed in

very moist and cool localities under the shade of huge trees like *Madhuca latifolia, Albizia lebbeck, Terminalia bellirica, Tectona grandis* and *Buchanania lanzan*. The simple, cordate leaves were exceptionally giant sized, and nearly as broad as long. The second and third leaves measured 69-72 x 60-69 cm across. The lowermost and the uppermost leaves were smaller. As many as 4-5 leaves were present on each main stem. Remains of the stems from the previous monsoon were also visible on many plants. This species is known to the locals as "Hasti-karn" i.e. elephant ears.

In the adjoining Udaipur district, Rajasthan, three plants were observed near Taloi village in Torna (I) Forest Block, Kotra Forest Range. There it is called "Hathni" i.e. female elephant, by the Bhils, a local tribe of the area. Kotra, (situated in the Aravalli range) the second locality of *L. macrophylla,* is nearly 250 km away from the first locality i.e. Sitamata, which is at the meeting point of the Aravalli and the Vindhyan ranges. The presence of *L. macrophylla* in Kotra Forest Range suggests that this species may also be present in Jhadol, Gogunda and Deola Forest Ranges of Udaipur district.

Study of the various floras of Rajasthan (Mehta 1979, Sharma and Tiagi 1979, Singh 1983, Shetty and Singh 1983, 1987-93) reveals that so far only two species of *Leea*, namely *L. edgeworthii* and *L. indica* have been recorded from Rajasthan and *L. macrophylla* is a new addition to the flora of this state, hence worth placing on record.

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29. ON A COLLECTION OF *BAUHINIA ACUMINATA* LINN. (LEGUMINOSAE: CAESALPINIOIDEAE) FROM MYANMAR

(With one text-figure)

A collection of *Bauhinia acuminata* L. from Myanmar (labelled "Katha district, near Ziyatin Forest rest house, 800 ft (244 m), 21.viii.1915, *C. Gilbert Rogers* 994 — CAL") drew my special attention because of the considerable length of the calyx-limb, which is 8.6 cm. The length of the calyx-limb of this species from Myanmar and its nearby regions, as given in or inferred from the revisionary and recent floristic accounts, varies from 2-5 cm, (Chen, *Lingnan Sci. J. 18(4)*: 489. 1939; de Wit, *Reinwardtia 3(4)*: 394. 1956; Soe, *Union Burma*

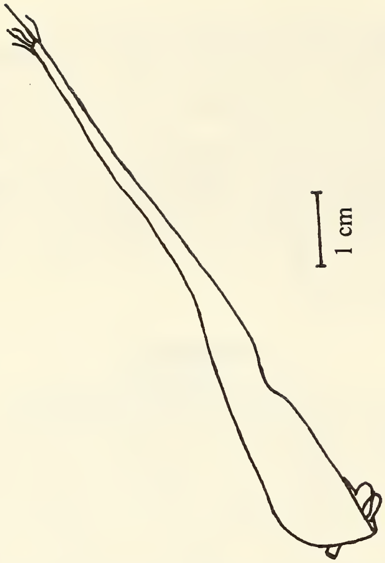

Fig. 1: *Bauhinia acuminata* Linn.: Calyx
After *C. Gilbert Rogers* – 994 CAL

J. Life Sci. 5: 310. 1972; Larsen & Larsen in Aubréville & Leroy (eds.), Fl. Cambodge, Laos & Viêt-nam 18: 156. 1980, in Smitinand & Larsen (eds.), Fl. Thailand *4(1)*: 13. 1984; Chen in Chen (ed.), Fl. Reipubl. Popul. Sin. 39: 153. 1988; Larsen & Larsen in Kalkman *et al.* (eds.), Fl. Males. *12(2)*: 445. 1996; Bandyopadhyay *et al.* in Fl. India 6 - in press). Further, the length of the calyx-teeth, whenever recorded in the above mentioned publications, was *c.* 3 mm but in the relevant specimen from Myanmar, one of the calyx-teeth measures 7 mm. The other four, however, are 3-4 mm in length.

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30. *ACHILLEA MILLEFOLIUM* LINN. (ASTERACEAE) — A NEW RECORD FOR KERALA STATE

Achillea millefolium L. (Asteraceae), commonly known as yarrow, is found throughout the temperate and boreal zones of the northern hemisphere and to a lesser extent, the southern hemisphere (Chandler *et al.* 1982). It grows abundantly throughout America and Europe (Falk *et al.* 1975). In India, it is common in the Himalaya from Kashmir to Kumaon at 1,050-3,000 m and is also seen growing in Bombay and the Belgaon (=Belgaum) areas (Anonymous 1985). In South India, it is reported from Nilgiri hills of Tamil Nadu (Henry *et al.* 1987). It is a popular medicinal plant used as tonic, stomachic, haemostatic, antispasmodic, antiseptic and antihepatotoxic (Thakur *et al.* 1989, Anon. 1985, Falk *et al.* 1975).

During a survey and collection of potential medicinal plants in 1992, the plant was observed along roadsides in Munnar forest areas of Idduki district. Hence, this is the first report of its occurrence from Kerala state.

Specimen Examined: Munnar Forest Area; Idduki district; Kerala; Field No. CIMAP 7118.

Fl. & Fr.: August-September.

ACKNOWLEDGEMENTS

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31. NEW RECORD OF PLANTS FROM ORISSA — II

Orissa is rich in plant wealth. The state has 13 districts. Koraput district, a part of the Eastern Ghats, lies on the border of Andhra Pradesh and Madhya Pradesh. Haines (1921-25), a pioneer explorer, collected very few plants from this district, though it is floristically rich. Later on, Mooney (1950) wrote on plants collected mostly from Western Orissa. During an ethnobotanical survey, the author collected some plants from this district. On comparison with the literature, and the specimens available at the Central National Herbarium (CAL), 3 taxa turned out to be new records for Orissa. Correct nomenclature, brief diagnostic characters, phenology, collection site, field numbers and notes on the ecology and distribution of these taxa have been recorded.

Stachytarpheta dichotoma (Ruiz & Pav.) Vahl

Enum. pl. 1: 207, 1804; forma *albiflora* (Moldenke) Moldenke, Phytologia 28: 102, 1974; Moldenke in Dass. and Fosb., Fl. Ceylon 4: 264, 1983; *Stachytarpheta australis* forma *albiflora* Moldenke, Phytologia 3:63, 1949; *Verbena dichotoma* Ruiz & Pav., Fl. Peru and Chil. 1:23, pl. 34b, 1798.

Family: Verbenaceae.

Annuals; branches dichotomous, obtusely tetragonal, light grey; branchlets densely pubescent. Leaves opposite, decussate; leaf blades membraneous, elliptic to ovate, acute, serrate along the margins, 1.5-6 cm long, 1-3 cm wide. Spikes terminal, slender, flaccid, 5-10 cm long, many flowered, black after drying. Corolla hypocrateriformis, white. Filaments white. Styles included, white.

Fl. & Fr.: May-December.

Specimen examined: Similguda (Koraput), coll. H.N. Subudhi, 8454

Remarks: Commonly grows along the road side; has white flowers.

Distribution: Jamaica, Brazil, Argentina, Sri Lanka, Malaya.

Ipomoea indica (Burm.) Merrill

Int. Rump. Herb. Amb. 495, 1917; Fosberg, Micronesica 2: 151, 1967; et in Bot. Notiser 129: 35-38, 1976; Bhandari. Fl. Ind. Desert. 228, f. 90, 1990; *Convolvulus indicus* Burm. in Rumph. Herb. Amb. Index Universalis, 7: 6, 1755; *Ipomoea congesta* R.Br., Prod. 485, 1810; Van Ooststr., Fl. Mal. 4: 465, 1953.

Family: Convolvulaceae.

Twiners, sometimes rooting at nodes, densely pilose. Leaves broadly ovate to orbicular, entire, 5-12 x 3-5 cm, cordate at base, shortly acuminate; petioles 2-15 cm long. Retrosely hairy. Inflorescence axillary peduncle, more or less retrosely pilose. Flowers in umbellate cymes; pedicels 2-8 mm long. Sepals herbaceous, 10-20 cm long. Corolla funnel shaped, glabrous, bright blue. Stamen and style included, with hairs at base. Ovary glabrous.

Fl.-Fr.: June-October.

Specimen examined: Similguda (Koraput), coll. H.N. Subudhi, 9597.

Remarks: Grows in wasteland and along road sides.

Distribution: Circumtropical

Illustration: Bhandari, Fl. Ind. Desert. 228. f.90, 1990.

Cyanotis arachnoidea

C.B. Clarke in A & C.DC.

Monogr. Phan. 3:250,1881; Matthew, Fl. Tam. Carn. 3:1661, 1983; *Cyanotis pilosa* (auct. non. Roem. & Sch.) Wight. Icon. PI. Indo. Orient t. 2083, 1853.

Family: Commelinaceae.

Semiprostrate herbs. Stems cottony or cobwebby. Leaves lanceolate, chartaceous, cobwebby; base obtuse; margin entire; apex rounded. Cymes terminal or axillary, 2-5 in clusters. Corolla blue. Stamens 6; filaments with hairs, yellow; anthers oblong. Ovary pilose.

Fl.-Fr.: June-September.

Distribution: Indian peninsula, Sri Lanka.

Remarks: Grows on rocky hills and in stone crevices.

Specimen examined: Similguda (Koraput) coll. H.N. Subudhi. 8464.

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